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Instruction Manual

MODEL 8100A

DIGITAL MULTIMETER

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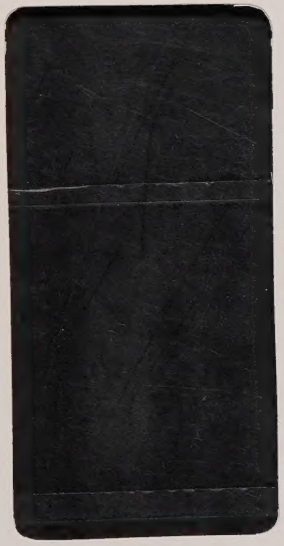
INSTRUMENTS / COMPONENTS



JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133

OCTOBER 1969

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MODEL 8100A

DIGITAL MULTIMETER

8100A serial no. _____ and on.

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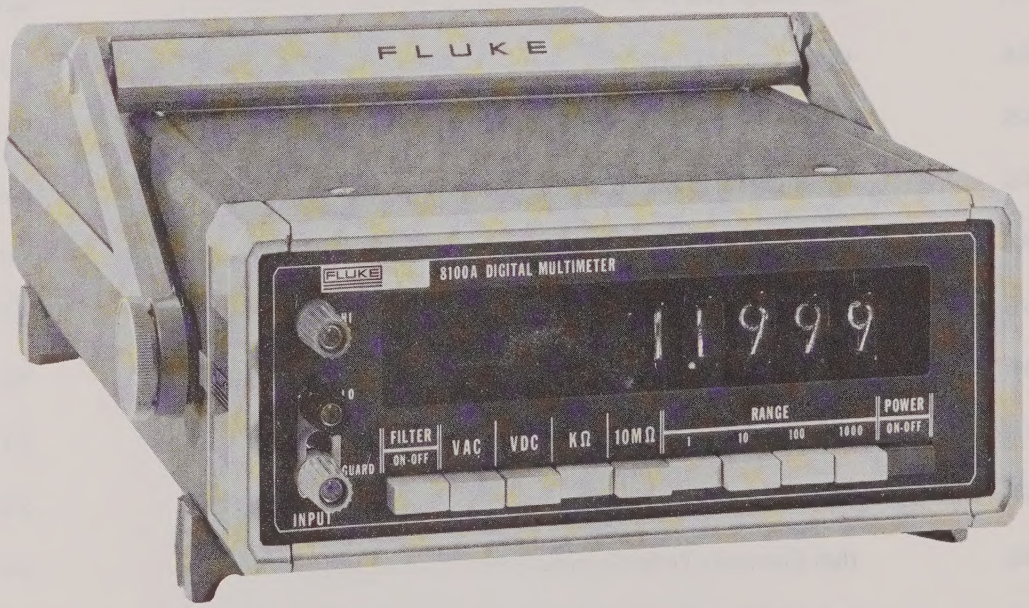


MODEL 8100A DIGITAL MULTIMETER

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. The Fluke Model 8100A Digital Multimeter is a versatile, accurate instrument, which measures ac and dc voltage in four ranges to 1000 volts and ohms in five ranges to 10 megohms. Standard features of the Model 8100A include full guarding, a switched two-pole active filter, autopolarity, pushbutton function and range selection, and full four-digit readout plus "1" for overranging. Fluke's unique Recirculating-Remainder (R^2)A/D conversion technique enables multiple use of discrete and integrated components for the various operating modes, thereby reducing parts count and power consumption while increasing reliability.

1-3. Accessories and options for the Model 8100A include the rechargeable battery pack (Option -01), High Frequency Probe, High Voltage Probe, Switched AC/DC Current Shunts, Front Panel Dust Cover, and Rack Mount Kit. A detailed description of the battery option and each accessory is given in Section VI of the manual.

1-4. ELECTRICAL SPECIFICATIONS

DC Volts

RANGE
±1, ±10, ±100, ±1000 volts dc with 20% overrange on all ranges.

RESOLUTION
0.01% of range (100 uv on 1v range maximum).

ACCURACY
30 days, 20°C to 30°C: ±(0.02% of input +0.01% of range).
90 days, 15°C to 35°C: ±(0.05% of input +0.01% of range).

DC INPUT RESISTANCE
Constant 10 megohms on all ranges.

FILTER
Switch selected two-pole, linear phase active filter.

RESPONSE TIME TO RATED ACCURACY
0.5 seconds with filter out.
1.5 seconds with filter in.

REJECTION

	INTERFERENCE FREQUENCY				
		60 Hz		50 Hz	
	DC	FILTER IN	FILTER OUT	FILTER IN	FILTER OUT
CMRR (1K in Low Lead)	120 db	120 db	100 db	120 db	100 db
NMRR	– – –	60 db	20 db	47 db	9 db

NOTE: CMRR = Common Mode Rejection Ratio
NMRR = Normal Mode Rejection Ratio
CMRR approaches infinity when instrument is battery operated.

POLARITY
Automatic, instantaneous selection and display.

OVERLOAD
±1200 vdc or ±1700v peak ac can be applied indefinitely on any range without damage.

AC Volts

RANGE
1, 10, 100, 1000 volts ac with 20% overrange on all ranges.

RESOLUTION
0.01% of range (100 uv on 1v range is maximum).

ACCURACY
90 days, 15°C to 35°C:

MIDBAND 50 Hz to 10 kHz	EXTENDED 30 to 50 Hz and 10 to 20 kHz
±(0.2% of input +0.05% or range)	±(0.5% of input + 0.1% of range)

INPUT IMPEDANCE
1 megohm shunted by <30 pf.

RESPONSE TIME TO RATED ACCURACY
3 seconds

MAXIMUM DC NORMAL MODE VOLTAGE
±1200 vdc.

NOTE: The sum of DC Normal Mode Voltage and peak ac voltage must not exceed ±1700v.

OVERLOAD
±1200 vdc or ±1700v peak ac from 30 Hz to 20 kHz can be applied indefinitely on any range without damage.

Resistance

RANGE
1k, 10k, 100k, 100k, and 10 MΩ with 20% overrange on all ranges.

RESOLUTION
0.01% or range (0.1 ohm on 1k range is maximum).

ACCURACY

	1k to 1000k	10M
30 days 20°C to 30°C:	±(0.05% of input +0.01% of range)	±(0.1% of input + 0.01% of range)
90 days, 15°C to 35°C:	±(0.1% of input + 0.02% or range) on all ranges	

CONFIGURATION
Two terminal, constant current.

VOLTAGE ACROSS INPUT
1.0v at full range.
1.2v at 20% overrange.
9v with open terminals.

POWER IN UNKNOWN R
⩽ 1 milliwatt in range and ⩽ 1.44 milliwatts at 20% overrange on the 1K range, decreasing by an order of magnitude per range to 100 nanowatts at 10 megohm.

RESPONSE TIME TO RATED ACCURACY

	1k to 1000k	10M
Filter Out	0.5 seconds	3.0 seconds
Filter In	2.0 seconds	10.0 seconds

OVERLOAD

1k Range	130 vrms may be applied indefinitely without damage.
10k to 10 MΩ	230 vrms may be applied indefinitely without damage.

MAXIMUM INPUTS

HI to LO	See OVERLOAD specifications by function.
LO to GUARD	100 vdc or peak ac.
GUARD to chassis	1200 vdc or 230v rms at 60 Hz.

POWER
8 watts from 115V/230V, ±10%, 50 to 500 Hz line with internal battery option –01. Eight hours continuous operation from the rechargeable nickel-cadmium batteries.

1-5. ENVIRONMENTAL SPECIFICATIONS

HUMIDITY RANGE
Meets all specifications to 80% relative humidity for temperatures ⩽ 35°C and 70% relative humidity for temperatures above 30°C to 50°C.

SHOCK AND VIBRATION
Meets requirements of MIL-T-21200 G and MIL-E-16400F.

STORAGE TEMPERATURE
–40°C to +75°C.
–40°C to +60°C for batteries.

Operating Temperature
0°C to +50°C.

Temperature Coefficient

FUNCTION	TEMPERATURE COEFFICIENT
DC Volts	±(0.0025% of reading + 0.001% of range)/°C
AC Volts	±(0.015% of reading + 0.005% of range)/°C
KΩ	±(0.0035% of reading + 0.0015% of range)/°C
10 MΩ	±(0.01% of reading + 0.002% of range)/°C

NOTE: Add temperature coefficient only outside of temperature limits noted in 30 and 90 day specifications.

1-6. MECHANICAL SPECIFICATIONS

Weight
8 pounds without batteries.
10 pounds with batteries.

Mounting
Tilt-down carrying handle detents into custom non-marring feet and serves as a tilt-up bail for bench use. The Model 8100A outline drawing is shown in Figure 1-1, with approximate overall dimensions.

1-7. GENERAL SPECIFICATIONS

Selection
Function and range selection is manual via mechanically interlocked pushbutton switches.

Display
Four decade neon in-line readout with polarity neon for dc volts and fifth digit for 20% overrange. Automatic decimal location.

Sample Rate
Three samples per second.

Accessories Available
High Frequency Probes
High Voltage Probes
Switched AC/DC Current Shunts
Front Panel Dust Cover
Rack Mount Kit

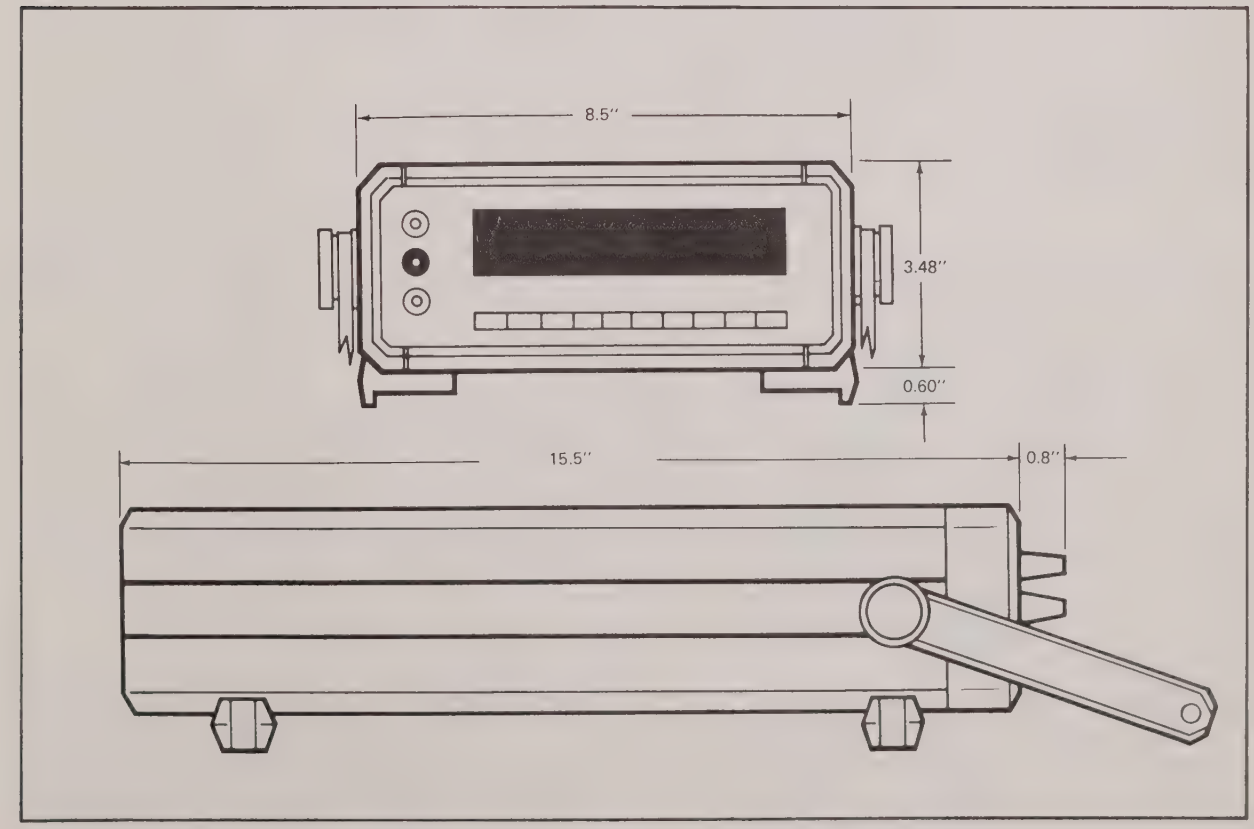


Figure 1-1. MODEL 8100A OUTLINE DRAWING

SECTION II

OPERATING INSTRUCTIONS

2-1. INTRODUCTION

2-2. This section contains operating instructions and applications information for the Model 8100A Digital Multimeter. Included in the instructions is a detailed description of the instrument controls, terminals, and indicators and an operational check, which verifies satisfactory operation of the instrument using only front panel controls. If any problem is encountered in operating the instrument, contact the nearest John Fluke Sales Representative or write directly to the John Fluke Manufacturing Company. Please include the instrument serial number when writing.

2-3. INSTALLATION

2-4. The Model 8100A is supplied with non-marring feet and tilt-down bail for bench or field use. Rack mounting kits for installation of one instrument or two instruments side-by-side in a standard 19 inch rack are available as accessories and are described in Section VI of the manual.

2-5. ACCESSORIES

2-6. The following Model 8100A accessories are available at additional cost. A detailed description of the accessories is given in Section VI of the manual.

High Frequency Probe
High Voltage Probes
Switched AC/DC Current Shunts
Front Panel Dust Cover
Rack Mount Kit

2-7. INPUT POWER REQUIREMENTS

2-8. The instrument operates on either 115 or 230 volt, 50 Hz to 500 Hz ac power or directly from the optional battery pack. Before applying ac power to the instrument, remove the bottom dust cover and note the position of the 115/230 volt slide switch at the rear of the instrument. If the switch does not indicate the desired operating voltage, proceed as follows:

a. Place the 115/230 volt switch in the position that corresponds to the desired operating voltage.

b. Ensure that the proper line fuse for the selected voltage is installed before operating the instrument. For 115 volt operation, the fuse should be 1/8 ampere slow-blow and for 230 volt operation, the fuse should be 1/16 ampere slow-blow.

c. Replace the bottom dust cover and connect the instrument to the line.

WARNING!

The round pin on the polarized three-prong plug connects the instrument case to power system ground. If a three-to-two-wire adapter is used or if the instrument is powered from batteries with the line cord disconnected, ensure that the instrument case is connected to a

high quality earth ground. This can be done by connecting a wire between the center pin on the rear panel ac connector and earth ground.

2-9. The optional battery pack supplies the operating power for the instrument whenever the ac power cord is disconnected from the ac line. The battery is charged by connecting the instrument to the ac line and turning the instrument on. The front panel meter monitors the charge on the battery during battery operation and during line operating it indicates LINE OPR (full scale). A detailed description of the battery option is provided in Section VI of the manual.

2-10. OPERATING FEATURES

2-11. The name and function of the front and rear panel controls, terminals, and indicators are shown in Figure 2-1.

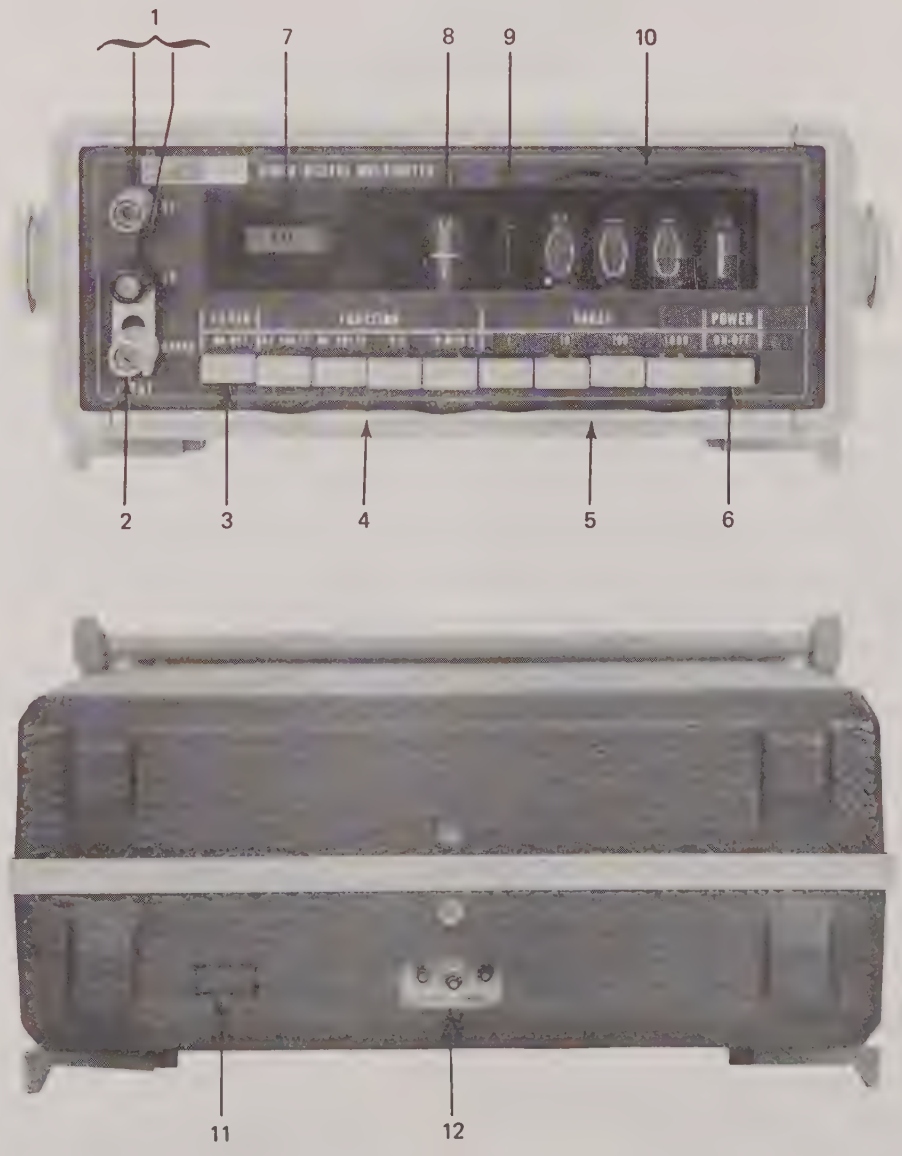


Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS (Sheet 1 of 2)

REF. NO.	NAME	FUNCTION
1	INPUT Terminals	Input connections for dc voltage, ac voltage, and resistance measurement.
2	GUARD Terminal	Connects to internal guard chassis. When properly connected externally, provides increased ac and dc common mode rejection. GUARD terminal may be connected directly to the LO terminal or disconnected from the LO terminal and driven by a separate GUARD potential.
3	FILTER ON–OFF Switch	Push on-push off switch selects the two-pole active input filter when depressed (ON) and reduces the amount of filtering when released (OFF).
4	Function Switches	Four pushbutton switches select the desired operating mode: VAC (ac voltage mode), VDC (dc voltage mode). KΩ (Kilohm mode), and 10 MΩ (10 megohm mode).
5	RANGE Switches	Four pushbutton switches select the full-scale input range for voltage or resistance measurement. Ranges of 1, 10, 100, and 1000 are provided for each function except 10 MΩ, which is fixed independent of the RANGE switch .
6	POWER Switch	Push ON - push OFF switch controls input power to the instrument. When depressed, instrument is ON; when released, instrument is OFF.
7	Battery Meter	Indicates charge condition of battery when the battery option is installed and the instrument is operating from the batteries. When the instrument is on the line and the batteries are charging, the meter indicates LINE OPR (full scale).
8	Polarity Indicator	Neon indicator tube indicates "+" when positive voltages are applied to the instrument and "–" when negative voltages are applied to the instrument.
9	Overrange Indicator	Neon indicator displays "1" for full-scale readout and 20% overrange on each range. When a maximum overrange input is applied to the instrument, in any operating mode, the readout will be 11999, with the decimal point positioned according to range.
10	Readout Tubes	Neon indicator tubes display the instrument readout from left to right, with the most significant digit displayed by the left-most tube. Each tube also displays a decimal point which, is operated by the RANGE switches.
11	115/230 Volt Switch	Slide switch selects the ac operating voltage for the instrument. Switch is not accessible until bottom dust cover is removed. NOTE: Refer to paragraph 2-7 for conversion instructions.
12	AC Line Connector	Mates with three-wire line cord for connection to 115/230 volt, 50 Hz to 500 Hz ac line.

Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS (Sheet 2 of 2)

2-12. OPERATIONAL CHECK

2-13. This test verifies satisfactory operation of the instrument, using only front panel controls. It is intended as a quick functional check only. In consideration of possible wide variation in ambient temperature, the tolerances on readouts have been extended accordingly.

a. Connect the Model 8100A to a source of 50 Hz to 500 Hz ac power or use the optional battery pack, as described in paragraph 2-7.

b. Jumper the LO terminal to the GUARD terminal with the shorting link provided and set the Model 8100A controls as follows:

POWER	ON
Function	VDC
RANGE	1000
FILTER	ON

c. The instrument readout should be 000.0 ±3 digits. The polarity indicator should register either "+" or "–".

d. Connect a shorting link between HI and LO INPUT terminals. Press, in turn, the 100 volt, 10 volt, and 1 volt RANGE switches. The instrument readout should be 00.00 ±3 digits, 0.000 ±3 digits, and .0000 ±1 digit, respectively.

e. Press the VAC function switch and the 1000 volt RANGE switch. The instrument readout should be between 000.0 and 001.5, with shorted INPUT terminals. The polarity indicator should not illuminate.

f. Remove the INPUT shorting link and press the KΩ function switch and 1 volt RANGE switch. Instrument readout should be full scale at 1.1999 (instrument attempts to measure infinite resistance between input terminals).

g. Short circuit the INPUT terminals. Instrument readout should be .0004 or less. Remove the short at the input.

NOTE!

Resistance of connections and shorting link must be less than 100 milliohms to obtain the indicated reading.

h. Press the 10 MΩ function switch. Instrument readout should be 11.999.

i. Short circuit the INPUT terminals. Instrument readout should be 0.004 or less.

2-14. A detailed performance test is given in paragraph 4-19 of the Maintenance section of the manual. It verifies performance of the instrument within the basic accuracy specifications using standard input signals and front panel controls only. It is suggested for use as a receiving inspection test for the instrument and to determine if the instrument is in calibration.

2-15. DC VOLTMETER OPERATION

2-16. The Model 8100A measures dc voltages in both polarities from 0 to 1000 volts, with 20% overrange capability in each of the four ranges. An active 2-pole filter is included and provides two modes of filtering. It may be switched in, if desired, to reduce the instrument response to noise. To operate the instrument as a dc voltmeter, proceed as follows:

a. Press the VDC function switch to place the instrument in dc voltage mode.

b. Select the desired full-scale voltage range by pressing the corresponding RANGE switch.

c. Select increased noise rejection by operating the FILTER switch (see filter specifications in the Section I). Note that response time to rated accuracy is increased from 0.5 seconds to 1.5 seconds with filter IN.

d. Connect the voltage to be measured to the INPUT terminals. The automatic polarity circuitry of the Model 8100A will activate appropriate circuitry in the instrument and the front panel polarity indicator will register a "+" if the HI input terminal is positive with respect to the LO terminal and "–" if the HI input terminal is negative with respect to the LO terminal.

2-17. AC VOLTMETER OPERATION

2-18. The Model 8100A measures ac voltage from 0 to 1000 volts at frequencies of 30 Hz to 20 kHz, with 20% overrange capability in each of four ranges. To operate the instrument as an ac voltmeter, proceed as follows:

a. Press the VAC function switch to place the instrument in ac voltage mode.

b. Select the desired full-scale voltage range by pressing the corresponding RANGE switch.

c. Connect the voltage to be measured to the INPUT terminals.

2-19. OHMMETER OPERATION

2-20. The Model 8100A measures resistance in five full-scale ranges of 1k, 10k, 100k, 1000k, and 10 megohms, with 20% overrange capability in each range. To operate the instrument as an ohmmeter, proceed as follows:

a. Select the KΩ function switch for measurement of resistances between 0 and 1000k and select the 10 MΩ switch for measurement of resistances between 1 and 10 megohms.

b. Select the desired full-scale resistance range in kilohm mode by pressing the corresponding RANGE switch. In 10 megohm mode, the range is fixed independent of the four range switches.

c. Connect the resistance to be measured to the INPUT terminals.

NOTE!

In both KΩ and 10 MΩ modes, the internal voltage arrangement is such that the HI input terminal is positive with respect to the LO input terminal.

2-21. OPERATING NOTES

2-22. Overload Protection

2-23. The Model 8100A is fully protected against overload in each function and on all ranges. In ac and dc voltage modes, ±1200 volts dc or 1700 volts peak ac from 30 Hz to 20 kHz can be applied indefinitely on any range without damage. In ohms mode, 130 volts rms may be applied indefinitely on the 1 kilohm range without damage, and 230 volts rms may be applied indefinitely on the remaining ohms ranges without damage.

2-24. Use of Guard Terminal

2-25. The instrument contains an isolated inner chassis, which is connected to the GUARD terminal on the front panel. When properly connected, the guard chassis reduces measurement errors due to common-mode currents. Ordinarily, the GUARD terminal is strapped to the LO terminal; however, it may also be driven by a separate guard voltage, with connections at a remote point. It should be noted that the guard voltage must be within 100 volt dc or peak ac of the LO input terminal.

2-26. APPLICATIONS

2-27. Transistor Testing

2-28. In KΩ and 10 MΩ modes, the Model 8100A produces a maximum of 9 volts, with 10 kilohms to 10 megohms in series, depending on range. The maximum current flowing in the unknown resistance is 0.7 milliamp. The maximum power dissipated in the unknown resistance is 2.0 milliwatts on the 1 kilohm range, decreasing by an order of magnitude per range to 200 nanowatts maximum at 10 megohms. Consequently, the instrument may be used to safely test most transistors. In both KΩ and 10 MΩ modes, the internal voltage arrangement is such that the HI input terminal is positive with respect to the LO terminal.

2-29. DBM Measurement

2-30. To use the Model 8100A as an ac output meter, terminate the circuit to be measured in its characteristic impedance and connect the Model 8100A directly across the load. For example, to measure output levels of a circuit having a characteristic impedance of 600 ohms, connect a 600-ohm load to the Model 8100A INPUT terminals. The resulting readout may be converted to dbm using the information provided in Figure 2-2.

MODEL 8100A READOUT	DBM LEVEL FOR 1 VOLT RANGE (1 mw in 600 Ω)
.0138	−35
.1092	−17
.2182	−11
.3083	− 8
.4352	− 5
.5490	− 3
.6150	− 2
.6897	− 1
.7746	− 0
.8700	+ 1
.9760	+ 2
Add 20 db for each range above one volt.	

Figure 2-2. AC VOLTAGE TO DBM CONVERSION TABLE FOR 600-OHM CIRCUITS

2-31. Measurement of High Resistances

2-32. In this application, the Model 8100A together with a stable external dc voltage is used to measure resistances in excess of 10 megohms.

a. Measure and record the external voltage, E_{bb}; then connect the equipment as shown in Figure 2-3.

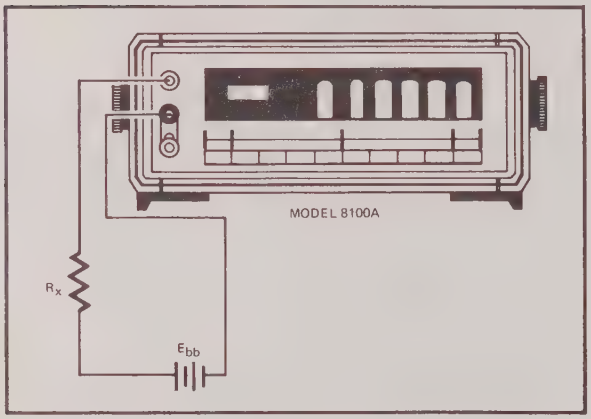


Figure 2-3. CIRCUIT CONNECTIONS FOR MEASUREMENT OF HIGH RESISTANCES

b. Record the Model 8100A readout.

c. Using the following calculations, determine the value of the unknown resistance, R_x.

$$R_x = \left(\frac{E_{bb}}{E_m} - 1 \right) R_m$$

Where E_{bb} = External DC Voltage (volts dc)
E_m = Model 8100A readout in step b. (volts dc)
R_m = 10 Megohm (10^7) $\pm$0.03%

2-33. Use As A Null Detector

2-34. The Model 8100A, with battery option, is ideally suited to many applications requiring a null detector. The high dc input resistance (10 megohms) and the autopolarity feature of the instrument make it ideal for monitoring small voltage differences in bridge circuits, potentiometers, and other measuring devices. Where circuit adjustment is required, the circuit is simply adjusted for a readout of all zeros on the Model 8100A, which provides 100 microvolt resolution on the 1 volt range.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. This section describes the theory of operation of the Model 8100A Digital Multimeter. In the general discussion, the functional interaction of circuits and groups of circuits, as depicted in the accompanying simplified drawings, is examined. The detailed circuit description is keyed to the instrument schematic, which is located at the back of the manual.

3-3. GENERAL THEORY

3-4. System Description

3-5. The Model 8100A consists of three main sections, the buffer, the analog-to-digital (A/D) converter, and the display. A simplified block diagram of the instrument is shown in Figure 3–1. The buffer accepts the input signal and converts it into a voltage suitable to drive the A/D converter. It scales and conditions all inputs and it performs ac to dc conversion. The A/D converter accepts the buffer output, determines the polarity of the voltage, and converts the voltage into a binary coded decimal (BCD) output. The analog storage circuit is used to retain digit information between measurement cycles so that a continuous display is provided. The display circuit accepts the BCD output from the A/D converter and converts it into a 10-line decimal output, which operates the Nixie® readout tubes. The power supplies provide operating voltages for each of the sections, a stable master reference voltage, and clock signals, which are the time base for the entire instrument.

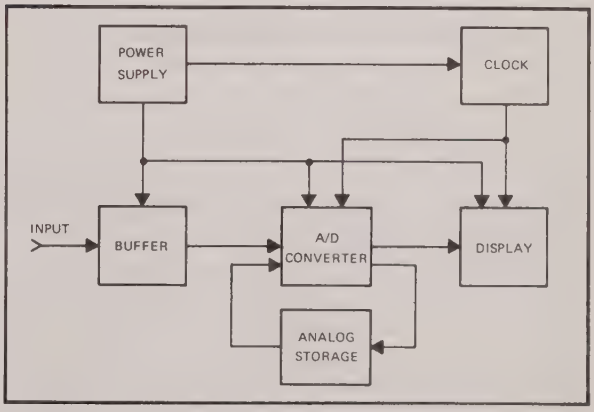


Figure 3-1. MODEL 8100A SIMPLIFIED BLOCK DIAGRAM

3-6. Buffer

3-7. The principal parts of the buffer are a resistive input divider, which scales the dc input voltages to 1 volt full scale; an active, switchable, two-pole input filter, providing an instrument response of either ½ or 1½ seconds, which removes unwanted ac signals from the dc input; and a low-drift, high-gain amplifier having a high input impedance. Depending on the function called at the front panel, the buffer is connected in one of the four modes of operation:

dc voltage (VDC), kilohms (KΩ), 10 megohm (10 MΩ), or ac voltage (VAC).

3-8. When the instrument is in dc voltage mode, the buffer is connected as shown in Figure 3-2. The dc input voltage (E_{in}) is applied to the resistive divider. The divider output is applied through the input filter to the buffer amplifier. The amplifier is connected as an inverting voltage follower and provides an output to the A/D converter which is the negative of the scaled-down input. The two diodes inside the negative feedback loop provide a threshold step, which supplies polarity information to circuitry in the A/D converter. Resistor R_L is the output load resistance.

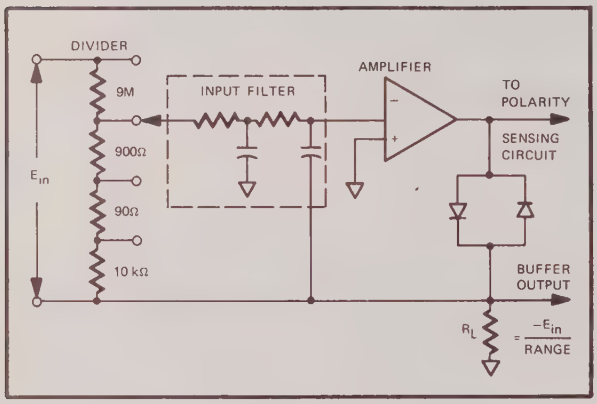


Figure 3-2. DC VOLTAGE MODE SIMPLIFIED DIAGRAM

3-9. In kilohm mode, the buffer is connected as shown in Figure 3-3. The same input divider, filter, and amplifier are used, except the input divider is connected to the +7 volt reference. In this circuit arrangement, the input divider is the input resistor of an operational amplifier, in which the +7 volt reference forms the input voltage and the unknown resistor (R_X) forms the feedback resistance. A voltage proportional to R_X is applied to the A/D converter and is equivalent to −0.7 volts full scale when the proper input divider tap is selected.

3-10. In 10 megohm mode, the buffer is connected as shown in Figure 3-4. The +7 volt reference voltage is divided down to 1 volt to limit the full-scale output of the buffer to 1 volt. In all other respects, the operation in 10 megohm mode is analagous to kilohm mode operation.

3-11. In ac voltage mode, the buffer is connected as shown in Figure 3-5. In this arrangement, the amplifier is used as an operational rectifier. A pair of rectifier diodes is placed inside a strong negative feedback loop, and a negative feedback signal proportional to the input voltage is

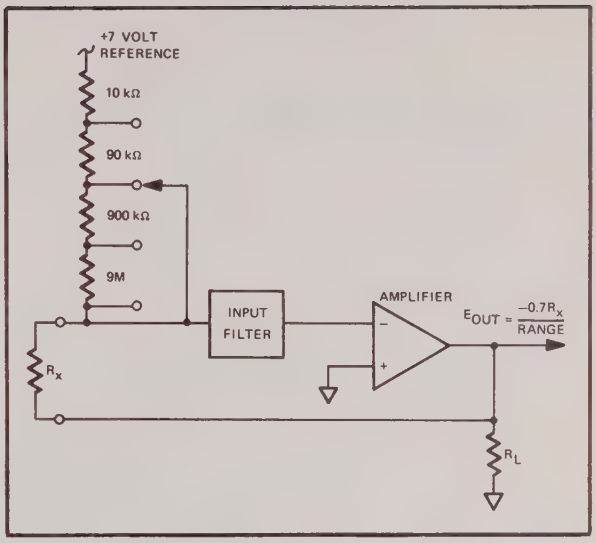


Figure 3-3. KILOHM MODE SIMPLIFIED DIAGRAM

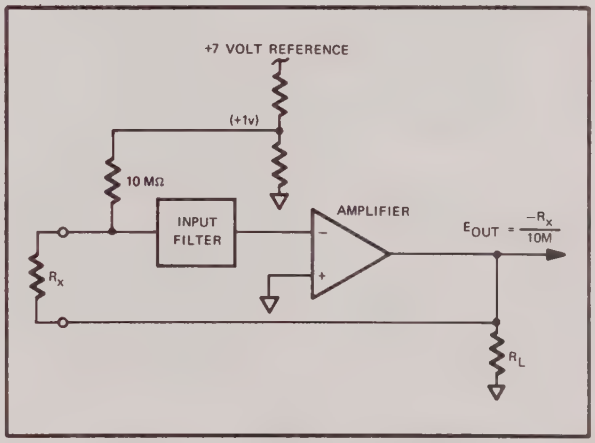


Figure 3-4. 10 MEGOHM MODE SIMPLIFIED DIAGRAM

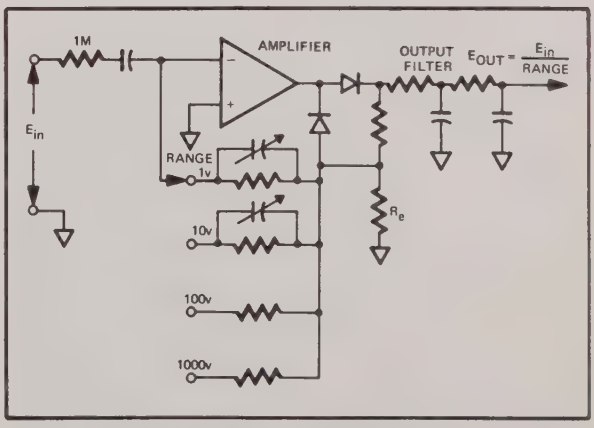


Figure 3-5. AC VOLTAGE MODE SIMPLIFIED DIAGRAM

developed across resistor R_e. The proper scale factor is determined by the feedback resistors, which are controlled by the front panel range switches. The positive half-cycles are filtered by a two-stage RC filter to provide a positive one volt output to the A/D converter that is scaled in terms of the rms value of a sine wave. Figure 3-6 gives the full-scale buffer outputs for each of the instrument functions.

FUNCTION	FULL-SCALE BUFFER OUTPUT (VOLTS DC)
+VDC	−1
−VDC	+1
KΩ	−0.7
10 MΩ	−1
VAC	+1

Figure 3-6. BUFFER OUTPUTS

3-12. A/D Converter

3-13. The A/D converter employs the unique recirculating-remainder (R^2) A/D conversion technique developed by FLUKE. A simplified diagram of the A/D converter and associated circuitry is shown in Figure 3-7. Accompanying the diagram is a chart showing the sequence of operation for an input of 0.6352 volts.

3-14. The A/D converter digitizes the input serially in four 4-millisecond time periods, with each period divided equally into digitizing and display periods, A and B. At the start of the measurement sequence, period 1A, the A to D converter samples the 0.6352 volt input. Then the analog output voltage from the X10 amplifier causes the comparator to output to the voltage controlled oscillator (VCO), and the VCO produces pulses, which are entered into the counter. When the total pulse count equals the most significant digit of the input or 6, the counter stops. The ladder produces a series of six 0.1 volt steps, which correspond to the counter output. The remainder of 0.0352 volts is amplified by the X10 amplifier and held in the sample and hold capacitor, C1. The display circuitry decodes the counter output and displays the 6 in period 1B. At the beginning of period 2, the 0.6352 volt input is disconnected from the input of the A/D converter and the 0.352 volt output of the sample and hold circuit is digitized and displayed as the new input. Successively, the remainders of 0.52 and 0.2 volts are digitized and displayed in the same manner. Although the four digits are digitized and displayed one at a time, the process proceeds at a sufficiently high rate of speed so that the display appears continuous to the eye.

3-15. The input voltage is sampled every 300 milliseconds. Since it only requires 20 milliseconds to digitize the input, a storage circuit is provided which stores a voltage representing each of the four digits on each of four capacitors. This stored information supplies the input during the remaining fourteen 20-millisecond periods, until the voltmeter is ready to sample the input voltage again.

3-16. Refer to the simplified A/D converter diagram in Figure 3-8 and assume that a +0.6352 volt signal is applied to FET switch, Q1. The polarity sensing circuit turns on Q1 and turns off Q2 and Q3 in response to the positive input signal and the stage-1 signal from the ring counter. (Note: The positive input refers to the signal at the input of the A/D converter. The actual instrument input signal is negative, but is inverted by the buffer.) The input signal is thus applied to the positive input of amplifier A2. The feedback loop for A2 is closed through resistor R_f, which is chosen to give an amplifier gain of 70. Thus, when the output of A2 is 7 volts, the voltage at e_s will be 0.1 volts. With 0.6352 volts at the positive input, amplifier A2 will attempt to place the same voltage at the negative input of A2; however, as the output of A2 swings past 7 volts, the comparator produces an output that turns on the VCO. The VCO produces a series of pulses, which are entered into the counter. The counter output causes the ladder to place a corresponding series of 0.1 volt steps into point e_s. When six pulses have entered the counter, the ladder output will be 0.6 volts and the output of A2 will drop below 7 volts. At this point, the VCO stops generating pulses and the voltage at e_s remains at 0.6 volts plus a remainder of 0.0352 volts, which is applied to e_s through R_f. The resulting voltage at e_R will then be exactly 0.352 volts or, in other words, ten times the remainder. The amplified remainder is applied through switch Q5 to the first sample and hold capacitor, C1.

3-17. Digitizing the 6 requires approximately 2 milliseconds or half of the first digitizing period, as shown in Figure 3-7. The 6, which is stored in the counter during the digitizing process, is then displayed by the display circuit. After approximately 2 milliseconds of display time, the display is turned off and the counter is reset to zero. Switch Q5 is then turned off, leaving capacitor C1 charged to 0.352 volts. At the same time, Q1 is switched off, removing the input from the A/D converter for the duration of the digitizing cycle, and the ring counter switches

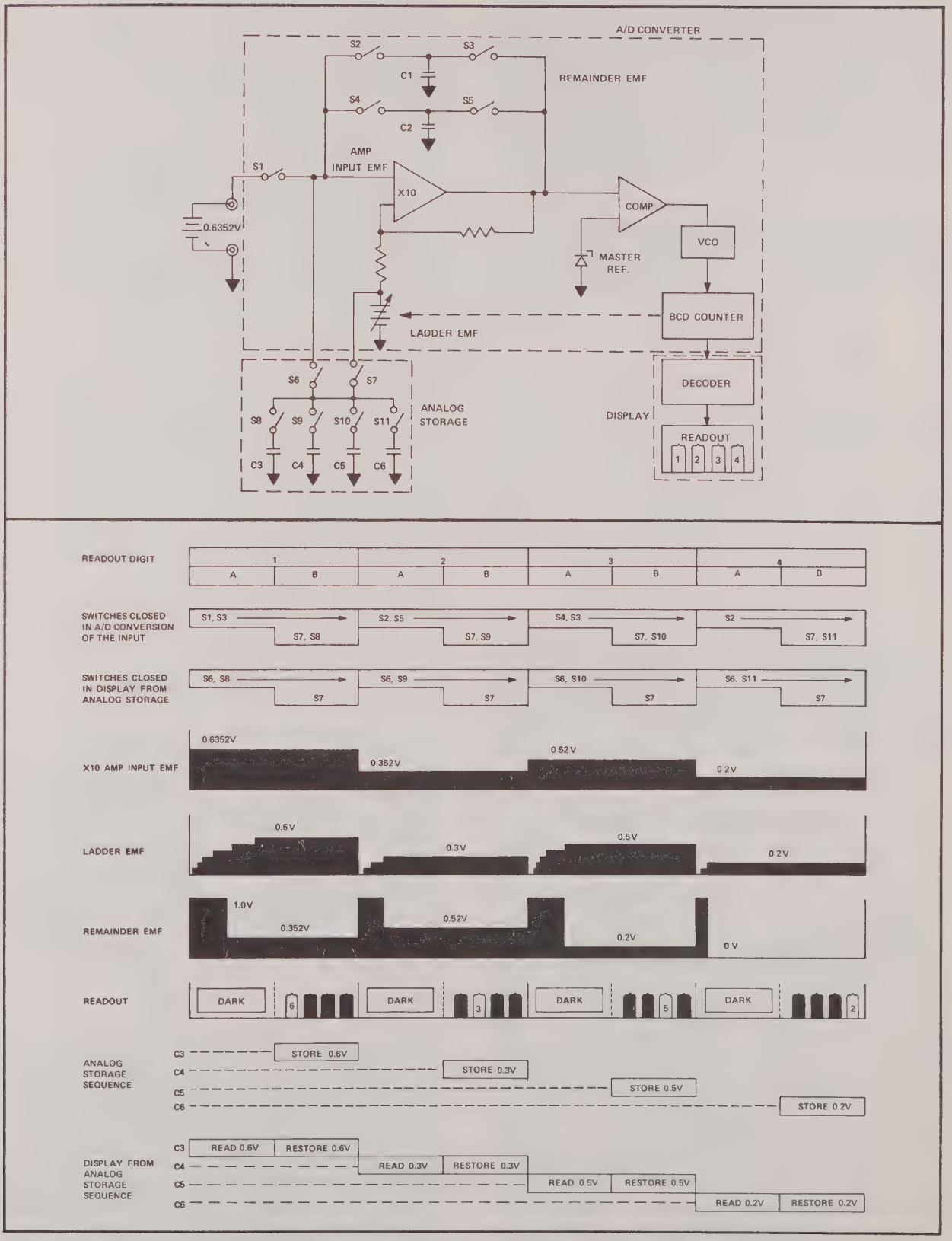


Figure 3-7. RECIRCULATING-REMAINDER A/D CONVERSION

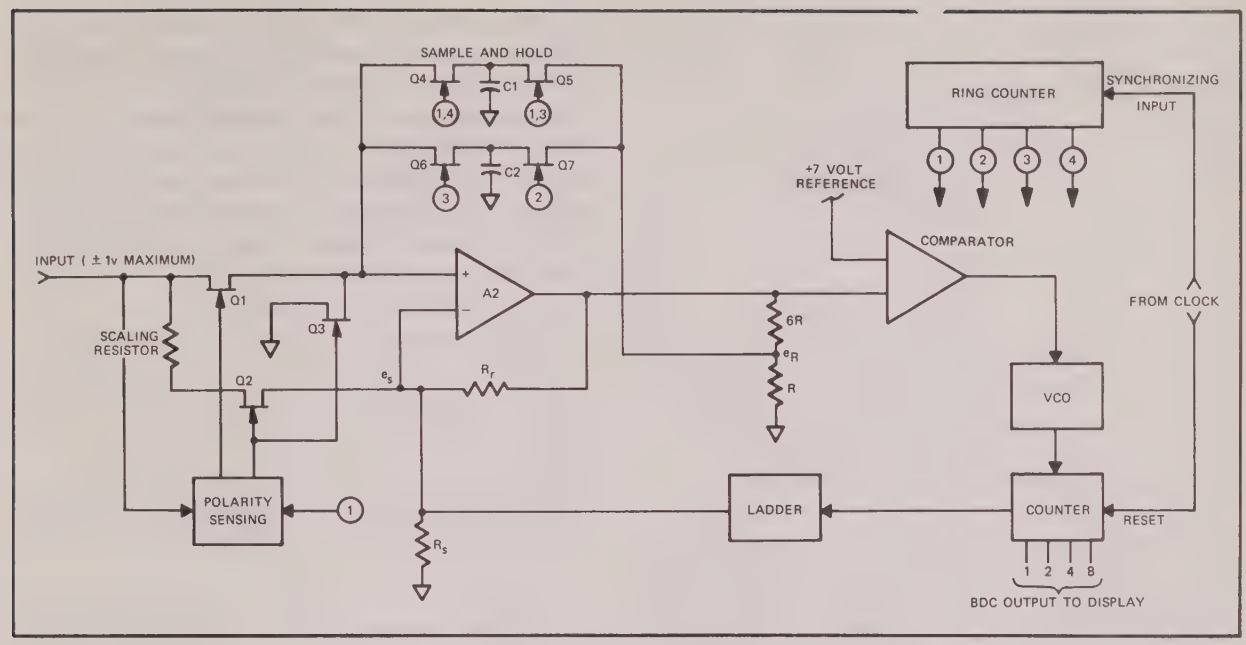


Figure 3-8. A/D CONVERTER SIMPLIFIED DIAGRAM

to stage 2, turning on switches Q4 and Q7. The 0.352 volts is then applied through Q4 to the input of A2 and is digitized as the new input signal. The resulting amplified remainder of 0.52 volts is stored in the second sample and hold capacitor, C2, while the 3 is digitized and displayed in the second Nixie®. The process is repeated twice more, digitizing both the 5 and the 2, with the amplified remainder alternately supplied by the two sample and hold capacitors.

3-18. If the A/D converter input voltage had been negative, the polarity sensing circuit would have turned on switch Q2 and Q3 instead of Q1 during the first period, and the voltage would have been applied to the negative input of A2, with Q3 holding the positive input of A2 at ground. With a negative input, both the ladder and resistor R_f are used as current summing resistors, since the negative input of amplifier A2 will be at virtual ground. The scaling resistor is the operational input resistance and is adjusted to set the amplifier gain to proper value. After the first digit is digitized, Q2 and Q3 are switched off and the remainder terms are digitized in the same manner as previously explained.

3-19. Analog Storage

3-20. A simplified diagram of the analog storage circuit is shown in Figure 3-9. This circuit accepts the 4-bit BCD output of the counter and converts it into an analog voltage, which corresponds to the displayed digit. The analog voltage is applied to the storage capacitors, through the FET input switch, during the display half of each clock cycle. Each of the four analog voltages is stored in a separate capacitor, which is switched into the circuit by the ring counter at the same time that the corresponding digit is being displayed. When the measure/store multivibrator switches to the storage mode, the FET output switch is turned on and the input voltage is disconnected from the input of the A/D converter. The analog voltages in the storage circuit are then applied, digit by digit, to the A/D converter input. The voltages are digitized, displayed, and then re-stored in the analog storage circuit. The storage readout cycle lasts for approximately 300 milliseconds, after which time the measure/store multivibrator switches to measure mode and the A/D converter input is reconnected to the input signal. There are approximately 14 cycles of storage for every measurement cycle, which provides a continuous display that changes (input is sampled) three times per second.

3-21. Display

3-22. The 4-line BCD output from the A/D converter, containing the digit information, is applied to the decoder/driver. The decoder/driver provides a 10-line output, which is connected to the Nixie® tube cathodes as shown in Figure 3-10. All Nixie® tube cathodes are connected in parallel so that the same digit is turned on in each tube. However,

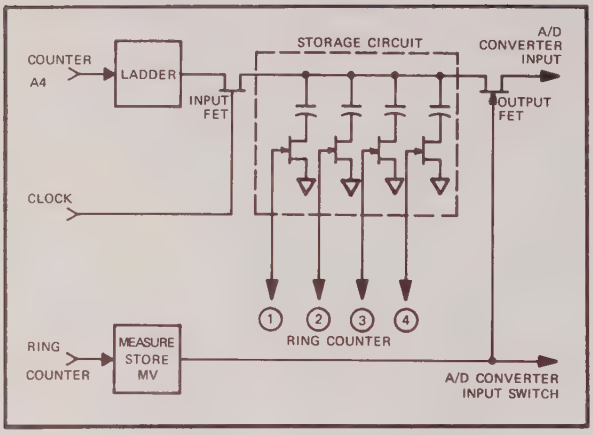


Figure 3-9. ANALOG STORAGE SIMPLIFIED DIAGRAM

only the Nixie®corresponding to the proper digit will be turned on by the ring counter. Therefore, all four digits are displayed on a time-share basis using one counter and one decoder/driver. The display cycle occurs during the second half of each digitizing period, as shown in Figure 3-7, whereas digitizing in the A/D converter occurs during the first half of the period.

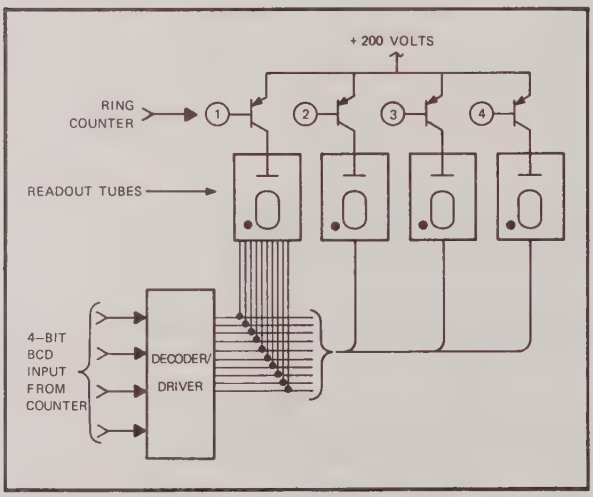


Figure 3-10. DISPLAY SECTION SIMPLIFIED DIAGRAM

3-23. Power Supply and Clock

3-24. All operating voltages for the Model 8100A are produced by a series of regulated power supplies that derive their voltages from a −18 volt regulator (see Figure 3-11). In line operated instruments, the −18 volt regulator is supplied raw voltage by a transformer/rectifier; and in battery operated instruments, voltage is supplied by rechargeable batteries. The −18 volt regulator output is used throughout the instrument as an operating voltage and is also applied to the inverter input. The inverter provides +17 volts dc to the +15 volt regulator, which, in addition to supplying instrument operating voltages, serves as source for the +7 volt reference. The inverter also provides a 200 volt peak square wave, which drives the Nixie® tubes, and +5 volts to operate the integrated logic circuitry. Finally, the inverter supplies the 250 Hz clock signal.

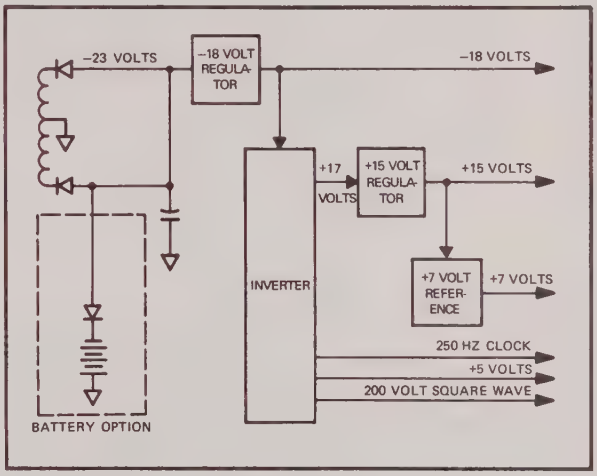


Figure 3-11. POWER SUPPLY AND CLOCK SIMPLIFIED DIAGRAM

3-25. CIRCUIT DESCRIPTION

3-26. Buffer

3-27. INPUT RANGE DIVIDER. In dc voltage mode, the input binding posts are connected across a four-position range divider consisting of three closely matched wirewound resistors, R158, R159, and R160 and a precision metal film resistor, R156. Resistor R157 is adjusted to provide an exact ratio between R156 and the other divider resistors. Depending on the range selected, the divider scales the input voltage down by a ratio of 1, 10, 100, or 1000 so that the output voltage of the divider will always be 1 volt full scale. In kilohm mode, the bottom of the input divider (R160) is disconnected from the LO binding post and connected to the +7 volt reference. When so connected, the divider acts as the current determining network for ohms measurement. Selection of the proper range places the required portion of the divider in series with the +7 volt reference. In all kilohm ranges, the voltage developed across the unknown resistor is 0.7 volts at full scale. In 10 megohm mode, the bottom end of the divider is connected to divider R152, R154, which is adjusted by R153 to provide an output of 1 volt. This 1 volt output sets the current through

the entire range divider to provide the proper scale factor; full scale output in 10 megohm mode is 1 volt.

3-28. INPUT FILTER. The output of the range divider is applied to an active, two-pole filter consisting of resistors R27 and R28 and capacitors C10 through C13. When the FILTER switch is ON, the filter consists of R27 and C10 in the first section and R28 and C12 in the second section and provides a settling time of 1.2 seconds and noise rejection of 60 db at 60 Hz. When the FILTER switch is OFF, C11 is placed in series with C10, and C13 is placed in series with C12, thereby reducing the settling time to 0.25 second and the noise rejection to 20 db at 60 Hz. Diodes CR11 and CR12, in conjunction with R27, protect both the filter and the buffer amplifier from excessive input voltages. In the 10 volt dc range, R27 is shorted out, since the output impedance of the range divider is 1 megohm and R27 is not needed.

3-29. BUFFER AMPLIFIER. The buffer amplifier consists of transistors Q77, Q79, and Q80 and amplifier A1. The first stage amplifier is Q77, a low-noise, low-drift JFET pair operating in common-source configuration. Potentiometer R175 is the zero adjustment control, which in conjunction with R176, R177, and R193 is used to reduce the initial offset of Q77 to zero. The output of Q77 drives A1, a monolithic operational amplifier that provides most of the voltage gain. Capacitor C51 is placed around A1 to provide a smooth roll-off through unity gain. Transistor Q79 is a common base output stage, which raises the output impedance of the amplifier as high as possible. To avoid degrading the high output impedance, Q79 operates into a constant current load, Q80.

3-30. In dc voltage, kilohm, and 10 megohm modes, the feedback loop for the unity gain buffer amplifier is completed through diodes CR14 and CR15, which provide a voltage step around zero to drive the polarity sensing circuit. Resistor R174 is the load resistor for the amplifier. In ac voltage mode, the buffer amplifier is connected as an operational amplifier, with R24 functioning as the input resistor. The input signal is coupled through capacitor C9 to the gate of Q77 and the negative feedback loop is completed through the range resistors, R29, R30, R31, and, R32. Diodes CR14 and CR15 act as an operational rectifier in ac voltage mode. A positive, half-wave rectified dc voltage, proportional to the average value of the ac input, is developed across R162 and R174. This voltage is smoothed by a two-stage filter composed of resistors R35 and R36 and capacitors C19 and C20. Potentiometer R34 (ACV CAL) is adjusted to provide a filter output of 1 volt for a full scale input on any instrument range. Because the input capacity of Q77, together with additional stray capacities, causes an additional pole in the loop response of the ac converter, trimmer capacitors C14 and C15 are provided on the two lowest ranges to adjust the frequency response through 20 kHz. Frequency adjustment is not necessary on the upper two ranges, because of the low resistance of R31 and R32.

3-31. A/D Converter

3-32. CLOCK. The clock signal, which is the master timing signal for the A/D converter, is taken from several windings on the inverter transformer, T102. Two separate clock signals are taken from the primary of T102; one is a gate control signal for the analog storage circuit and the sample and hold circuit, and the other is used to strobe the Nixies®. One phase of the clock signal at the secondary of T102 is used to synchronize the ring counter, while both phases are applied to NAND gate A3A to provide a delayed reset pulse for counter A4. The timing diagram for the A/D converter is shown in Figure 3-12. The first period of the measurement cycle, as shown in the diagram, is set aside for removal of the zero offset of the A/D converter amplifier.

3-33. RING COUNTER. The five-stage ring counter consists of transistors Q19 through Q24 and associated components. The ring counter will free run at a frequency slightly less than the clock frequency. However, the clock signal forces the counter to speed up, thereby synchronizing the five counter periods with the clock. The purpose of Q24 is to prevent two pulses from entering the ring at one time. At the end of the fifth period in the measurement cycle, the ring counter supplies a synchronizing signal to the measure/store multivibrator.

3-34. POLARITY SENSING CIRCUIT. The polarity sensing circuit consists of transistors Q13, Q14, and Q15 and associated components. At the beginning of the second period in every measurement cycle, Q13 is turned on by the second stage signal from the ring counter. As soon as Q13 turns on, the polarity sensing circuit responds to the voltage step which appears at R40. If the instrument input voltage is negative, the voltage step at R40 will be positive, transistor Q15 will conduct, and the signal at the collector of Q15 in conjunction with the signal from the measure/store multivibrator (Q25) will turn on FET switch Q16. Switch Q16 then connects the positive buffer output voltage at test point 9 (TP9) to the positive input of the A/D converter amplifier. If the instrument input is positive, Q14 will conduct and the signal at the collector of Q14 in conjunction with the signal from Q25 will turn on FET

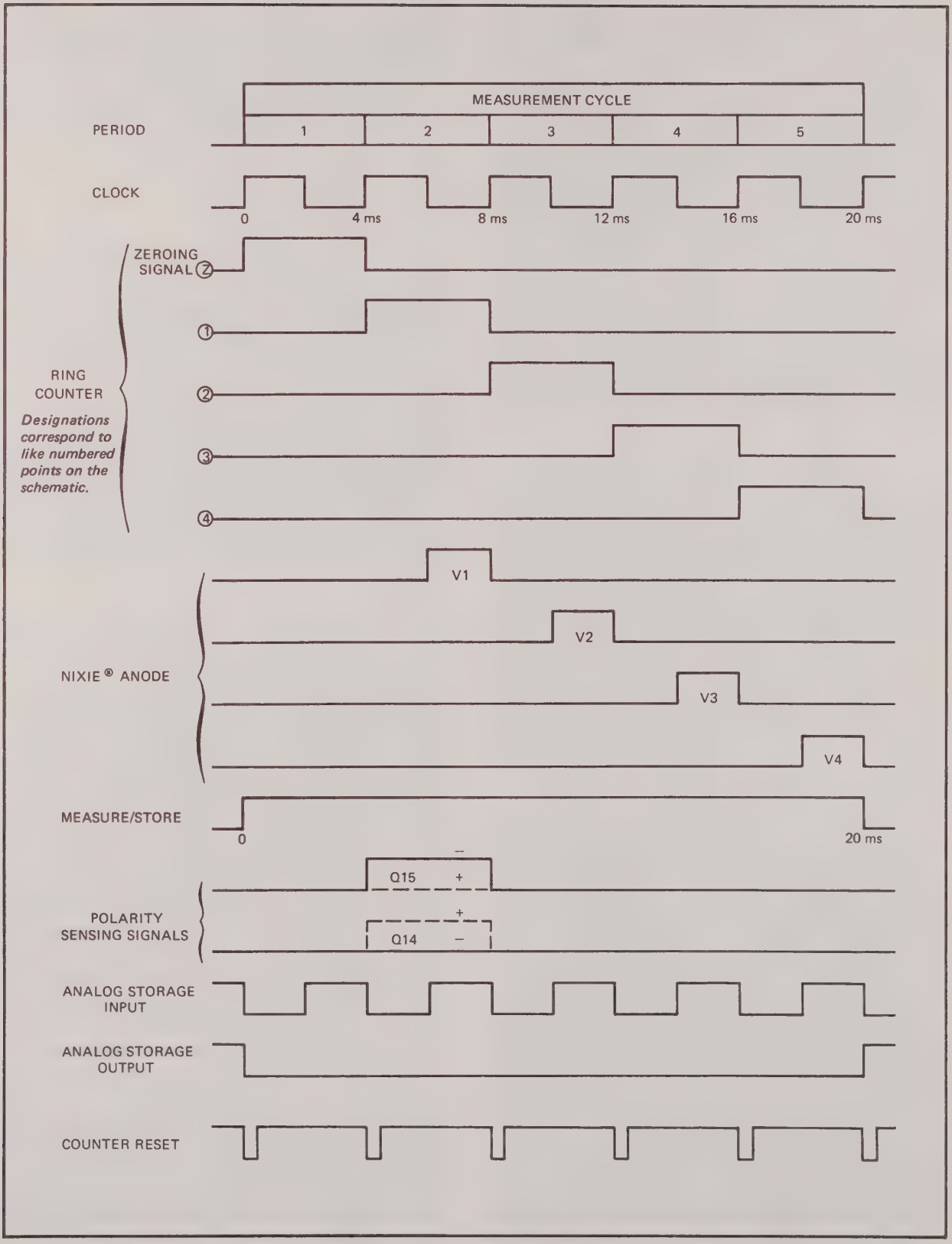


Figure 3-12. TIMING DIAGRAM

switches Q12 and Q17. The negative buffer output will then be applied through scaling resistors R50 and R51 and switch Q12 to the negative input of the A/D converter amplifier. At the same time, the positive input of the amplifier will be connected to ground through switch Q17. Resistors R186 and R187 provide a small offset correction voltage to the positive input.

3-35. A/D CONVERTER AMPLIFIER. The amplifier consists of dual FET Q53, operational amplifier A2, and associated circuitry. Transistors Q76 and resistor R110 comprise a clamp, which prevents amplifier A2 from saturating while the output is above 7 volts. Transistor Q83 and resistor R184 clamp the output of amplifier A2 on strong negative signals, such as FET switching transients. The remainder feedback loop is completed through the comparator, which consists of transistor Q54 and diodes CR29 and CR30, and through the remainder resistor R98 to the input of A2. During the first period, or zeroing period, of each measurement cycle, transistors Q58 and Q18 are switched on by the ring counter. Transistor Q58 connects the output of the amplifier to the zero-holding capacitor C37, while Q18 connects the positive input of the amplifier to ground. This operation places the offset of Q53 across C37 and effectively removes it for the balance of the measurement cycle. The amplifier is able to satisfy itself through these feedback loops as long as the input does not exceed 0.1 volts. When the input exceeds 0.1 volt, the output of A2 attempts to rise above 7 volts, which causes the comparator to output to the VCO through current source Q61.

3-36. VOLTAGE CONTROLLED OSCILLATOR. The VCO consists of multivibrator Q59, Q60. The VCO has no output until it is supplied current by current source Q61. When the output of A2 exceeds 7 volts, the difference is passed on to Q61 by the comparator and Q61 begins to conduct. The pulse repetition rate of the VCO is proportional to the magnitude of the driving current. The greater the current flowing into the base of Q59, the greater the number of pulses per unit time. The output of the VCO is applied to the input, pin 1, of counter A4.

3-37. COUNTER. The counter is a monolithic ripple counter, having an output which corresponds to a standard 8-4-2-1 binary code. The VCO output is applied to the clock input of the counter and the reset pulse from A3A is applied to the clear input. The output of counter A4 is applied to the decoder/driver, A5, and the ladder.

3-38. LADDER. The output of counter A4 is applied to the ladder switches and their drivers, transistors Q40 through Q51. The ladder switches drive two ladders. The primary ladder consists of precision resistors R79, R84, R89, R94, and R77 and produces an output that corresponds to the actual value of the digital input. The secondary ladder, which drives only the analog storage circuit, consists of resistors R75, R78, R83, R88, and R93 and produces an output that is slightly in excess of the actual value of the digital input. Each ladder comprises a 4-bit, weighted-resistor digital-to-analog converter. The analog output of the ladders is weighted in terms of seventieths of the reference voltage (+7 volts) so that they can be programmed for a 0.1 volt output for each digital bit at the input.

3-39. SAMPLE AND HOLD. The sample and hold circuit consists of FET switches Q34 through Q39 and capacitors C34 and C35. During the second period of the measurement cycle, the amplified remainder is applied to C35; however, Q35 is inhibited from conducting during the first half of the period by the clock signal which is coupled through diode CR36 to its gate. During the second half of the second period, Q35 is switched on and the amplified remainder is applied to capacitor C34. During the third period, Q35 is switched off, Q36 is switched on, and the remainder is applied through FET switches Q34 and Q27 to the input of amplifier A2. At the same time, Q39 is switched on and the next remainder is applied to capacitor C35. During the fourth period, Q39 is switched off and Q37 and Q38 are switched on. The input is then supplied by the remainder voltage held on C35, while the next amplified remainder is stored on C34. In the final period of the measurement cycle, only Q34 is switched on to supply the final remainder voltage to the input of A2. Upon completion of the fifth period, the A/D converter input is connected to the instrument input voltage (if in measure mode) or the analog storage output voltage (if in storage mode) and the circulation of the new remainder proceeds in the same manner as before.

3-40. Analog Storage

3-41. The analog storage circuit consists of the secondary ladder (discussed in paragraph 3-38), the measure/store multivibrator, and the storage circuit.

3-42. MEASURE/STORE MULTIVIBRATOR. The measure/store multivibrator, consisting of transistors Q25 and Q26, is basically a one-shot multivibrator with dual synchronizing inputs. The measurement cycle, which is approximately 20 milliseconds in duration, is coincident with conduction of Q25; and the storage cycle, which is approximately 330 milliseconds in duration, is coincident with conduction of Q26. The multivibrator is triggered at

the end of each measurement cycle by the trailing (negative) edge of the signal at the collector of Q24. During the measure cycle, a signal is coupled to the polarity sensing circuit from the collector of Q25. This signal enables switch Q16 for positive signal measurement or switches Q12 and Q17 for negative signal measurement. In storage mode, this signal is not present and, consequently, the input voltage will not be connected to the A/D converter.

3-43. STORAGE CIRCUIT. The storage circuit consists of FET switches Q28 through Q33 and capacitors C30 through C33. The output of the secondary ladder is supplied to the appropriate storage capacitor through Q28, which is switched on during display time. The first digit is stored in C30, the second in C31, the third in C32, and the fourth in C33. When the measure/store multivibrator switches to storage mode, Q29 is switched on and the analog voltages stored in the capacitors are applied, serially, to the input of A2.

3-44. Display

3-45. The decoder/divider is a monolithic BCD-to-decimal decoder, which accepts the 4-bit BCD output of counter A4, decodes each digital word, and selects one of ten decimal output drivers. The ten driver outputs are applied to the readout tube cathodes.

3-46. The readout tubes are operated by the 200 volt square wave, which originates in the power supply and corresponds in frequency to the clock. During the second half of each clock period (display time), the inverter supplies the full 200 volts to the anode drive line. The anodes are turned on by switches Q67 through Q70 and current sources Q71 through Q74. The switches, which are operated by the ring counter, turn on only one readout tube during each period of the measurement cycle. At the same time, the output of the decoder/driver is applied to the appropriate cathode of each of the four readout tubes and the digit is then visually presented in proper decimal position.

3-47. The overrange digit lamp, DS2, is operated by transistor Q66, which is connected in an AND configuration with gate A3C. When the output of counter A4 reaches ten, transistor Q66 conducts and turns on DS2. The function of gate A3B and transistor Q65 is to clamp the output of the VCO when counter A4 has a count of eleven during the first period of the measurement cycle (first digit) or a count of nine during any subsequent periods. The polarity sign indicator, V5, is operated by transistors Q81 and Q82, which are driven by the polarity sensing circuit.

3-48. Power Supply

3-49. Power for the Model 8100A is supplied either by the ac power line via power transformer T101 or by the internal rechargeable battery pack, BT1 (Option-01). The secondary of T101 is tapped for two output voltages. The higher voltage is rectified by diodes CR32 and CR33 and is used to charge the batteries through ballast lamp DS11. The ballast lamp regulates or limits battery charging current to ensure a safe level of charging current regardless of battery condition. The lower voltage is rectified by diodes CR1 and CR2 to provide operating voltage for the instrument. The voltage at filter capacitor C1 is always greater than the battery voltage during power line operation; therefore, diode CR34 is back biased, thereby preventing drain from the batteries during power line operation. The rectified power line voltage is fed through fuse F2 to a series regulator consisting of pass element Q1, driver Q2, and voltage amplifier Q3. This regulator provides −18 volts to operate the inverter and supply negative power supply voltages for the instrument. Meter M1 is placed across the pass element to provide an indication of battery condition.

3-50. The inverter is a transformer-coupled multivibrator consisting of driver transistors Q4 and Q5, transformer T102, and RC timing network C4, R6, and R7. The inverter derives its operating voltage from the −18 volt supply and is energized as soon as instrument power is applied. It operates at a frequency of approximately 250 Hz. The square wave at the primary of T102 is rectified by diodes CR5 and CR6 to provide positive voltage to operate the +15 volt regulator. The +15 volt regulator consists of pass element Q6, driver Q7, and voltage amplifier Q8. The +15 volt regulator obtains its reference from the zener diode portion of reference amplifier Q11. In addition to supplying positive power supply voltages to operate the instrument, the +15 volt regulator also supplies the input for the +7 volt reference supply.

3-51. The +7 volt reference supply consists of compound emitter follower Q9, Q10, which is driven by reference amplifier Q11. The reference voltage is set precisely by R23 (–DC CAL control). Since the +7 volt reference supply must sink as well as supply current, resistor R181 is shunted across the output to draw a constant 2 milliamps from the supply. Also, diode CR10 is placed across the output of the supply to prevent current reversal during overload in the KΩ or 10 MΩ modes.

3-52. A high voltage tap in the primary of T102 supplies voltage to a half-wave voltage doubler consisting of diode CR3 and capacitor C6. The 200 volt output of the doubler is used to operate the Nixie® tubes, V1 through V4; the overrange indicator, DS2; and the polarity indicator, V5. Filtered dc voltage for operation of the integrated circuit logic is provided by diodes CR7 and CR8 and capacitor C44 in the secondary of T102.

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

4-2. This section contains information and instructions concerning preventive and corrective maintenance for the Model 8100A Digital Multimeter. Preventive maintenance consists primarily of cleaning the instrument and should be performed as often as operating conditions require. Corrective maintenance consists of troubleshooting, calibration, and performance test procedures, which are designed to aid in maintaining instrument operation within specifications. Section III of the instruction manual is an important supplement to the troubleshooting section, since a thorough knowledge of instrument theory is indispensable in troubleshooting.

4-3. A calibration interval of 90 days is recommended to ensure instrument operation within the 90-day specifications stated in Section I of the manual and a calibration interval of 30 days is recommended for operation within the 30-day specifications. The performance of the instrument should be verified in accordance with the performance tests in paragraph 4-19 before calibration is attempted. An instrument that meets all of the requirements of the performance tests need not be calibrated. An instrument that does not meet the requirements of the performance tests will require troubleshooting or calibration.

4-4. SERVICE INFORMATION

4-5. Each instrument manufactured by the John Fluke Manufacturing Company is warranted for a period of one year upon delivery to the original purchaser. Complete warranty information is contained in the Warranty page located at the rear of the manual. Factory authorized calibration and repair service for all Fluke Instruments is available at various world wide locations. A complete list of factory authorized service centers is located at the rear of the manual. If requested, an estimate will be provided to the customer before any repair work is begun on instruments which are beyond the warranty period.

4-6. TEST EQUIPMENT

4-7. The equipment recommended for performance testing, troubleshooting, and calibration of the Model 8100A, together with the minimum specifications required in each case, is listed in Figure 4-1. If the recommended equipment is not available, other equipment which meets the required specifications may be used.

4-8. GENERAL MAINTENANCE

4-9. Access/Disassembly

4-10. All circuit board components except indicator tubes are accessible after removing the dust covers and guard chassis. The indicator tube access procedure is given in paragraph 4-15. The following procedure may be used to gain access to all components except tubes.

a. Remove the top and bottom dust covers and the narrow trim strips just above and below the readout tubes.

EQUIPMENT NOMENCLATURE	SPECIFICATIONS REQUIRED	RECOMMENDED EQUIPMENT
DC Voltage Source	Range: 0 to ±1000 vdc Accuracy: ±0.005% of setting Stability: ±0.0005% of setting or 20 uv (whichever is greater).	Fluke Model 343A DC Voltage Calibrator
AC Voltage Source	Voltage Range: 0 to 100 vrms Voltage Accuracy: ±0.05% of setting (50 Hz to 10 kHz) ±0.1% of setting (10 kHz to 20 kHz) Voltage Stability: ±0.002% of setting per 24 hours. Frequency Range: 1 kHz to 20 kHz	Hewlett Packard Model 745A AC Calibrator
Precision Resistors 1.0000k 10.000k 100.00k 1000.0k	Accuracy: ±0.01% Power Capability: 2 mw minimum	General Radio Type 1440 Standard Resistor
Precision Resistor 10 MΩ	Accuracy: ±0.01%	
Autotransformer	Voltage: 0 to 130 vac Current: 3 amp	General Radio Model W5MT3AW Metered Variac
Wattmeter	Power: 0 to 200w	
Multimeter	Accuracy: ±2% dc volts ±3% ac volts Input Impedance: 11 MΩ dc 1 MΩ ac	Fluke Model 853A Differential Multimeter
High Impedance or Differential DC Voltmeter	Range: 0 to ±1000 vdc Accuracy: ±0.02% of input Input Impedance: 10^7 ohms minimum	Fluke Model 8300A Digital Voltmeter
Oscilloscope	Vertical Sensitivity: 0.1v/cm minimum Sweep Speed: 0.5 usec/cm minimum Probe: High Impedance (10 MΩ)	Tektronix Type 545A Oscilloscope with Type 1A1 Dual Trace Plug-In

Figure 4-1. TEST AND CALIBRATION EQUIPMENT

b. Remove the top guard chassis (1) by disconnecting the spade-lug chassis-connecting wire located on the right-rear of the chassis, (2) by disconnecting the two battery leads at the printed circuit board (if battery option is installed), and (3) by removing the four chassis mounting screws, which are located on the instrument side rails.

CAUTION!

Do not remove the six screws located on the top of the guard chassis. These screws are for battery pack access only and should not be removed until the guard chassis is completely removed from the instrument.

c. Remove the bottom guard chassis by removing the four screws which hold it in place.

4-11. Fuse Replacement

4-12. Instrument fuses are located inside the instrument. The line fuse is located in a fuse block attached to the inside of the rear panel and is accessible from the bottom of the instrument after removing the bottom dust cover. The power supply fuse is mounted in fuse clips, which are attached to the printed circuit board near the power transformer. This fuse is accessible from the top of the instrument after removing the top dust cover. Correct values for the fuses are as follows:

REFERENCE DESIGNATION	FUNCTION	RATING
F1	Line fuse	115 volt operation: 1/8 ampere slow-blow 230 volt operation: 1/16 ampere slow-blow
F2	Power supply fuse	AGC 1/4 ampere

4-13. 115/230 Volt Conversion

4-14. The Model 8100A may be operated from either 115 or 230 volt ac power, depending upon the connection of the power transformer (T101) primary winding. Convert the instrument from one type of power line operation to the other by the following procedure:

a. Disconnect the instrument from the power line.

b. Place the 115/230 slide switch, located at the rear of the instrument, in the position which corresponds to the desired operating voltage.

c. Ensure that the proper line fuse for the selected voltage is installed (paragraph 4-11) before operating the instrument.

4-15. Lamp and Tube Replacement

4-16. The ballast lamp, DS11, is soldered in place on the circuit board and is located at the rear of the instrument near the power transformer. It is accessible after removing the top and bottom dust covers. The readout tubes, V1 through V4, and the polarity indicator, V5, are mounted in tube sockets and are located inside the molded black tube cover at the front of the circuit board. To gain access to the tubes, proceed as follows:

a. Remove the top and bottom dust covers and the narrow trim strips just above and below the readout tubes.

b. Remove the tilt-down bail assembly.

c. Remove the small nut and washer located just to the right of the INPUT terminals (viewed from the top) on the inside of the front panel.

d. Remove the eight screws (four on either side) which hold the front panel assembly to the side rails.

e. Pull the front panel assembly forward to the extent permitted by the INPUT terminal wiring.

f. Remove the molded tube cover by removing the two nuts located beneath the tube cover on the underside of the circuit board.

4-17. Cleaning

4-18. The instrument should be cleaned periodically to remove dust, grease, and other contamination. Cleaning should not be necessary too often, however, since the instrument is completely enclosed with no fans or vents. Care has been taken to prevent electrical leakage through the use of switches having high quality insulating materials and through special attention to component layout. The following procedure should be adhered to when cleaning the instrument:

a. Remove loose contamination with low–pressure clean, dry air. Pay particular attention to the front panel binding posts and binding post wiring.

b. The front panel and exterior surface may be cleaned using anhydrous ethyl alcohol or a soft cloth dampened in a mild solution of detergent and water.

CAUTION!

Do not use aromatic hydrocarbons or chlorinated solvents on the front panel, because they will react with the Lexan binding posts.

4-19. PERFORMANCE TESTS

4-20. The performance tests compare instrument performance to the accuracy specifications in Section I of the manual to determine if the instrument is in calibration. Known voltages are applied to the instrument input in dc and ac voltage modes, and resistance standards are connected to the input in kilohm and 10 megohm modes. The performance tests should be conducted before any instrument maintenance or calibration is attempted. The tests are also suited to receiving inspection of new instruments. Performance tests should be conducted under the following test conditions: ambient temperature 25°C, ±5°, relative humidity less than 70%. An instrument that fails any of the performance tests will require corrective maintenance or calibration. In case of trouble, analysis of the test results, with reference to the troubleshooting section, should help to locate the trouble.

NOTE!

Permissible tolerances for dc voltage and resistance measurements are derived from the 30–day instrument specifications, and tolerance for ac voltage measurements are derived from the 90–day specifications.

4-21. DC Voltage Test

4-22. In the following procedure, dc voltages are applied to the instrument at 100% of full scale on the 10, 100, and 1000 volt ranges and at 10% and 100% of full scale on the 1 volt range. A dc voltage source having the specifications shown in Figure 4-1 is required for this test.

a. Connect the Model 8100A to the ac line.

b. Set the Model 8100A controls as follows:

POWER	ON
Function	VDC
RANGE	As required
FILTER	ON

c. Apply each of the input voltages shown in Figure 4-2, in turn, to the INPUT terminals of the Model 8100A. The Model 8100A readout should be as indicated.

INPUT (VOLTS DC)	MODEL 8100A	
	RANGE	READOUT LIMITS
+1000	1000	+999.7 to +1000.3
+100	100	+99.97 to +100.03
+10	10	+9.997 to +10.003
+1.0001	1	+.9998 to +1.0004
+0.0999	1	+.0998 to +.1000
+0.1000	1	+.0999 to +.1001

Figure 4-2. DC VOLTAGE TEST REQUIREMENTS

d. Repeat step (c) with negative input voltages. The Model 8100A readout should be the same as for positive inputs, except that the polarity indication should be negative (–).

4-23. AC Voltage Test

4-24. In this test, full-scale voltages are applied to the instrument input at 100% of full scale on the 1, 10, and 100 volt ranges and at 10% of full scale on the 1000 volt range. The 1 and 10 volt ranges are checked at 1 kHz, 10 kHz, and 20 kHz and the 100 and 1000 volt ranges are checked at 1 kHz only. An ac voltage source having the specifications shown in Figure 4-1 is required for this test.

a. Connect the Model 8100A to the ac line.

b. Set the Model 8100A controls as follows:

POWER	ON
Function	VAC
RANGE	As required
FILTER	ON

c. Apply the ac test signals shown in Figure 4-3 to the Model 8100A INPUT terminals. The readout should be as indicated.

4-25. Ohms Test

4-26. The ohmmeter section of the instrument is checked by measuring standard resistors, which correspond to full-

INPUT		MODEL 8100A	
FREQUENCY (KHZ)	RMS VOLTS	RANGE	READOUT LIMITS
1	1	1	.9975 to 1.0025
1	10	10	9.975 to 10.025
1	100	100	99.75 to 100.25
1	100	1000	099.3 to 100.7
10	1	1	.9975 to 1.0025
10	10	10	9.975 to 10.025
20	1	1	.9940 to 1.0060
20	10	10	9.940 to 10.060

Figure 4-3. AC VOLTAGE TEST REQUIREMENTS

scale readings on each ohms range. The required specifications for the standard resistors are given in Figure 4-1.

a. Connect the Model 8100A to the ac line.

b. Set the Model 8100A controls as follows:

POWER	ON
Function	As required
RANGE	As required
FILTER	ON

c. Connect each of the standard resistors shown in Figure 4-4, in turn, to the INPUT terminals of the Model 8100A (use short, low-resistance connecting leads); set the RANGE and function switches as required. The Model 8100A readout should be as indicated.

STANDARD RESISTANCE	MODEL 8100A		
	FUNCTION	RANGE	READOUT LIMITS
1.0000k	KΩ	1	.9994 to 1.0006
10.000k	KΩ	10	9.994 to 10.006
100.00k	KΩ	100	99.94 to 100.06
1000.0k	KΩ	1000	999.4 to 1000.6
10 MΩ	10 MΩ	—	9.989 to 10.011

Figure 4-4. OHMS TEST REQUIREMENTS

4-27. TROUBLESHOOTING

4-28. This section contains information selected to assist in troubleshooting the Model 8100A. Before attempting to troubleshoot the instrument, however, it should be verified that the trouble is actually in the instrument and is not caused by faulty external equipments or improper control settings. For this reason, the performance tests (paragraph 4-19) are suggested as a first step in troubleshooting. The performance tests may also help to localize the trouble to a particular section of the instrument. If the performance tests fail to localize the trouble, the following individual tests may be helpful. Figure 4-7 shows the location of the major circuit areas in the instrument.

4-29. Power Consumption

4-30. This test verifies proper power consumption by the instrument.

a. Connect the Model 8100A through an ammeter to the ac line.

b. Press the POWER–ON switch and observe the reading on the ammeter. With only the POWER–ON switch depressed, the ammeter should indicate 42 milliamps (±4 milliamps) for an instrument without batteries or 80 milliamps (±10 milliamps) for an instrument with batteries.

4-31. Power Supply

4-32. In this test, each of the power supply output voltages is checked, using a voltmeter accurate to at least ±0.025%.

a. Connect the Model 8100A to the ac line.

b. Turn on the instrument. Function, RANGE, and FILTER switches may be in any position.

c. Connect the voltmeter common to the Model 8100A common (TP1) and measure the voltages as shown in Figure 4-5. The voltages should be as indicated.

VOLTAGE TEST POINT	DC VOLTS	
	NOMINAL	LIMITS
Either terminal of fuse F2	−23 −24	Battery Operation: −19 to −24 Line Operation: −24 minumum
Collector (case) of Q1	−18	−17.5 to −18.5
+ Terminal of C5	+17	+16.5 to +17.5
+ Terminal of C7	+15	+14.5 to +15.5
+ Terminal of C8	+7	+6.993 to +7.007
+ Terminal of C44	+5	+4.5 to +5.5

Figure 4-5. POWER SUPPLY VOLTAGE REQUIREMENTS

4-33. Buffer Amplifier

4-34. In this test, the buffer output voltage is compared with the instrument input voltage to determine if the buffer is operating properly. It is checked in ac and dc voltage modes.

a. Set the Model 8100A controls as follows:

POWER	ON
Function	VDC
RANGE	1
FILTER	ON

b. Connect +1.0000 volts dc to the INPUT terminals.

c. Connect a high impedance voltmeter between instrument common (TP1 or TP5) and TP9. The voltmeter should indicate −1.0000 ±0.0003 volts dc.

d. Press the VAC function switch and connect a 1.0000 volt, 1 kHz signal to the instrument INPUT terminals. The voltmeter should indicate +1.0000 ±0.0025 volts dc.

4-35. Linearity

a. Set the Model 8100A controls as follows:

Function	VDC
RANGE	1
FILTER	OFF

b. Apply each of the following voltages, in turn, to the INPUT terminals. The instrument readout should be as indicated.

NOTE!

The readout limits apply only to instruments that have just been calibrated. If necessary, perform the DC Voltage Calibration procedure (paragraph 4-44) before proceeding.

INPUT (VOLTS DC)	MODEL 8100A READOUT LIMITS
−1.1999	−1.1998 to −1.2000
−1.0999	−1.0998 to −1.1000
−0.9999	− .9998 to −1.0000
−0.8999	− .8998 to − .9000
−0.7999	− .7998 to − .8000
−0.6999	− .6998 to − .7000
−0.5999	− .5998 to − .6000
−0.4999	− .4998 to − .5000
−0.3999	− .3998 to − .4000
−0.2999	− .2998 to − .3000
−0.1999	− .1998 to − .2000
−0.0999	− .0998 to − .1000

c. If voltages are not correct, the ladder resistors should be checked for proper value.

4-36. Waveforms

4-37. In the following test, a dc test voltage is applied to the instrument and the main signal waveforms are examined, using an oscilloscope.

a. Set the Model 8100A controls as follows:

POWER	ON
Function	VDC
RANGE	1
FILTER	ON

b. Apply any stable dc voltage, within the range of the instrument, to the INPUT terminals.

c. Connect the oscilloscope between each of the test points shown in Figure 4-6 and instrument common (TP1 or TP5), using ac coupling; set the oscilloscope controls as shown. A stylized version of the desired signal is shown on the main schematic diagram. Note that the A/D converter amplifier and VCO waveforms will vary, depending on input voltage value.

SIGNAL	TEST POINT	OSCILLOSCOPE	
		VERTICAL SENSITIVITY	SWEEP SPEED
Clock	Junction of R53 and R54	1v/cm	0.5 ms/cm
Ring Counter	TP3	10v/cm	5 ms/cm
A/D Converter Amplifier Output*	TP2	5v/cm	2 ms/cm
VCO	Collector of Q60	5v/cm	2 ms/cm
Q35 Gate	Gate of Q35	10v/cm	5 ms/cm
Counter Reset	Pin 2 of A4	5v/cm	1 ms/cm

*Waveform will be slightly different every fifteenth reading.

Figure 4-6. SIGNAL LOCATIONS AND OSCILLOSCOPE SETTINGS FOR WAVEFORM CHECK

4-38. CALIBRATION

4-39. Calibration of the Model 8100A consists of the following ordered steps: zero adjustment, dc voltage calibration, input divider adjustment, kilohm calibration, 10 megohm calibration, and ac voltage calibration. The following equipment is required for calibration of the Model 8100A: a dc voltage source, an ac voltage source, and precision 1.0000k, 10.000k, 100.00k, 1000.0k, and 10 megohm resistors. A description of this equipment together with required specifications is given in Figure 4-1. Before attempting calibration, instrument performance should be examined according to the performance tests in paragraph 4-19 to ensure that no malfunctions exist. Calibration should be performed under the following test conditions; ambient temperature 25°C ±5°C, relative humidity less than 70%.

4-40. Adjustment Locations

4-41. All controls required for calibration and troubleshooting are accessible from the bottom of the instrument after removing the bottom dust cover. The controls are reached through the bottom guard chassis, which contains access holes that are marked according to the corresponding calibration control. Use an insulated screwdriver for all adjustments.

4-42. Preliminary Operations

a. Connect the Model 8100A to the autotransformer and adjust the autotransformer for 115 volts output.

b. Attach all covers and allow the instrument to warm up for at least 1 hour.

4-43. Zero Adjustment

a. Set the Model 8100A controls as follows:

Function	VDC
RANGE	1000
FILTER	ON

NOTE!

Front panel switch positions should be maintained from step to step unless otherwise instructed.

b. Adjust the ZERO control (R175) for a readout of 000.0.

4-44. DC Voltage Calibration

a. Set the Model 8100A controls as follows:

Function	VDC
RANGE	1
FILTER	ON

b. Apply −1.0000 volts dc to the INPUT terminals and adjust the −DCV CAL control (R23) for a readout of −1.0000. Tap the potentiometer to ensure that it is in a stable position.

c. Apply +1.0000 volts dc to the INPUT terminals and adjust the +DCV CAL control (R50) for a readout of +1.0000.

d. Apply −0.0998 volts dc to the INPUT terminals and adjust the REMAINDER ADJ control (R149) for a readout of −.0998.

e. Apply +0.0998 volts dc to the INPUT terminals. The instrument readout should be +.0998. Repeat steps (b) and (c), as required, until the readout is correct for both polarities.

4-45. Input Divider Adjustment

a. Press the 100 volt RANGE switch.

b. Apply −100.00 volts dc to the INPUT terminals and adjust the INPUT DIV ADJ control (R157) for a readout of −100.00.

c. Apply −10.000 volts dc to the INPUT terminals and press the 10 volt RANGE switch. The instrument readout should be −10.000.

d. Press the 1000 volt RANGE switch and apply −1000.0 volts dc to the INPUT terminals. The instrument readout should be −1000.0.

e. Re-adjust the INPUT DIV ADJ control, if necessary, for an exact readout in steps (b), (c), and (d).

4-46. Kilohm Calibration

a. Set the Model 8100A controls as follows:

Function	KΩ
RANGE	1
FILTER	ON

b. Short the INPUT terminals with a shorting bar. The readout should be either .0000 or .0001.

c. Connect a 100.00k resistor to the INPUT terminals and press the 100 kilohm RANGE switch. Adjust the K OHM CAL control (R48) for a readout of 100.00.

d. Connect each of the following resistors to the INPUT terminals and set the RANGE switches as indicated. The input readout should be as shown.

INPUT RESISTANCE	RANGE	READOUT
1.0000k	1	1.0000 ±1 digit
10.000k	10	10.000 ±1 digit
100.00k	100	100.00 ±1 digit
1000.0k	1000	1000.0 ±1 digit

4-47. 10 Megohm Calibration

a. Press the 10 MΩ switch, and connect a 10 megohm resistor to the INPUT terminals.

b. Adjust the 10 MEG CAL control (R153) for a readout of 10.000 ±2 digits.

4-48. AC Voltage Calibration and Final Zero Adjustment.

a. Attach the top guard chassis, if it is not already in place.

b. Set the Model 8100A controls as follows:

Function	VAC
RANGE	100
FILTER	OFF

c. Apply a 100 volt rms, 1 kHz signal to the INPUT terminals and adjust the ACV CAL control (R34) for a readout of 100.00.

d. Press the 10 volt RANGE switch.

e. Apply a 10 volt rms, 20 kHz signal to the INPUT terminals and adjust the 10V HF ADJ control (C15) for a readout of 10.000.

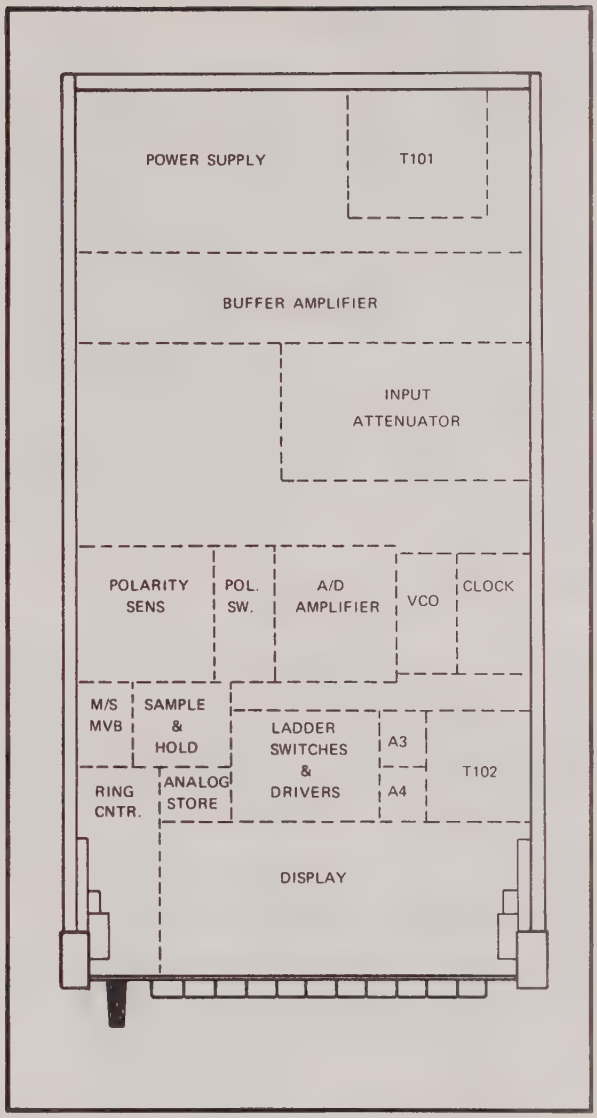


Figure 4-7. LOCATION OF THE MAJOR CIRCUIT AREAS

f. Apply a 1 volt rms, 20 kHz signal and press the 1 volt RANGE switch. Adjust the 1V HF ADJ control (C14) for a readout of 1.0000.

g. Apply a 1 volt rms, 10 kHz signal to the INPUT terminals. The readout should be 1.0000 ±.0007; if it is not correct, re-adjust the 1V HF ADJ control until it is.

h. Recheck the reading of step (f). It should be between .9980 and 1.0020.

i. Calibration of the Model 8100A is complete.

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section of the manual contains a listing of replaceable components for this instrument. The first listing contains a complete breakdown of all the major assemblies followed by subsequent listings that itemize the components on each major assembly. An illustration accompanies each major assembly listing to aid in locating the listed components.

5-3. Assemblies and subassemblies are identified by a reference designation beginning with the letter A followed by a number (e.g., A1 etc.). Electrical components appearing on the schematic diagram are identified by their schematic diagram reference designation. Components not appearing on the schematic diagram are consecutively numbered throughout the parts list. These components are identified with whole numbers on the arrow call-out illustrations and by index numbers on the grid illustrations. Flagnotes are used throughout the parts list and refer to special ordering explanations that are located in close proximity to the flagnotes.

5-4. COLUMN DESCRIPTION

a. The REF DESIG column indexes the item description to the associated illustration. In general the reference designations are listed under each assembly in alpha-numeric order. Subassemblies of minor proportions are sometimes listed with the assembly of which they are a part. In this case, the reference designations for the components of the subassembly may appear out of order.

b. The INDEX NO. column lists coordinates which locate the designated part on the associated grid illustrations.

c. The DESCRIPTION column describes the salient characteristics of the component. Indention of the description indicates the relationship to other assemblies, components, etc. In many cases it is necessary to abbreviate in this column. For abbreviations and symbols used, see the following page.

d. The six-digit part number, by which the item is identified at the John Fluke Mfg. Co., is listed in the STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives.

e. The Federal Supply Code for the item manufacturer is listed in the MFR column. An abbreviated list of Federal Supply Codes is included in the Appendix.

f. The part number which uniquely identifies the item to the original manufacturer is listed in the MFR PART NO. column. If a component must be ordered by description, the type number is listed.

g. The TOT QTY column lists the total quantity of the items used in the instrument and reflects the latest Use Code. Second and subsequent listings of the same item are referenced to the first listing with the abbreviation REF. In the case of optional subassemblies, plug ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the TOT QTY column lists the total quantity of the item in that particular assembly.

h. Entries in the REC QTY column indicate the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of every part in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

i. The USE CODE column identifies certain parts which have been added, deleted or modified during

the production of the instrument. Each part for which a Use Code has been assigned may be identified with a particular instrument serial number by consulting the Serial Number Effectivity List at the end of the parts list. Sometimes when a part is changed, the new part can and should be used as a replacement for the original part. In this event a parenthetical note is added in the DESCRIPTION column.

5-5. HOW TO OBTAIN PARTS

5-6. Standard components have been used wherever possible. Standard components may be ordered directly from the manufacturer by using the manufacturer's part number, or parts may be ordered from the John Fluke Mfg. Co. factory or authorized representative by using the Fluke part number. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-7. You can insure prompt and efficient handling of your order to the John Fluke Mfg. Co. if you include the following information:

a. Quantity.

b. FLUKE Stock Number.

c. Description.

d. Reference Designation.

e. Instrument model and serial number.

Example: 2 each, 177105, Transistors, 2N3565, Q107-108 for 845AR, s/n 168.

If you must order structural parts not listed in the parts list, describe the part as completely as possible. A sketch of the part, showing its location to other parts of the instrument, is usually most helpful.

5-8. LIST OF ABBREVIATIONS

ac	alternating current	MHz	megahertz	rfi	radio frequency interference
Al	Aluminum	M	megohm		
amp	ampere	met flm	metal film	res	resistor
assy	assembly	ua	microampere	rms	root mean square
cap	capacitor	uf	microfarad	rtry	rotary
car flm	carbon film	uh	microhenry	sec	second
C	centrigrade	usec	microsecond	sect	section
cer	ceramic	uv	microvolt	S/N	serial number
comp	composition	ma	milliampere	Si	silicon
conn	connector	mh	millihenry	scr	silicon controlled rectifier
db	decibel	m	milliohms	spdt	single-pole, double-throw
dc	direct current	msec	millisecond	spst	single-pole, single-throw
dpdt	double-pole, double-throw	mv	millivolt	sw	switch
dpst	double-pole, single-throw	mw	milliwatt	Ta	tantalum
elect	electrolytic	na	nanoampere	tstr	transistor
F	fahrenheit	nsec	nanosecond	tvm	transistor voltmeter
Ge	germanium	nv	nanovolt	uhf	ultra high frequency
gmv	guaranteed minimum value	Ω	ohm	vtvm	vacuum tube voltmeter
h	henry	ppm	parts per million	var	variable
Hz	hertz	piv	peak inverse voltage	vhf	very high frequency
hf	high frequency	p-p	peak to peak	vlf	very low frequency
IC	integrated circuit	pf	picofarad	v	volt
if	intermediate frequency	plstc	plastic	va	voltampere
k	kilohm	p	pole	vac	volts, alternating current
kHz	kilohertz	pos	position	vdc	volts, direct current
kv	kilovolt	P/C	printed circuit	w	watt
lf	low frequency	rf	radio frequency	ww	wire wound

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		DIGITAL MULTIMETER - Figure 5-1	8100A					
A1		Printed Circuit Assembly (See Figures 5-2 and 5-3)	269753	89536	269753	1		
F1		Fuse, fast acting, ¼ amp, 250v (for 115v operation)	109314	71400	Type AGC	1		
F1		Fuse, fast acting, 1/8 amp, 250v (for 230v operation)	196790	71400	Type AGC	1		
J1		Binding, post, red, HI	275552		820-65	1		
J2		Binding post, black, LO	275560		820-45	1		
J3		Binding post, blue, GUARD	275578		820-55	1		
P1		Connector, male, 3 contact	222612	82389	AC3G	1		
S11		Switch, slide, dpdt	226274	82389	46256-LF	1		
T101		Transformer, power	275354	89536	275354	1	1	
W1		Line cord (not illustrated)	226100	70903	17258	1	1	
XF1		Holder, fuse	103283	71400	4405	1		
1		Cable, AC Power	269779	89536	269779	1		
2		Cable, Input	269761	89536	269761	1		
3		Cover, bottom (not illustrated)	269639	89536	269639	1		
4		Cover, top (not illustrated)	269647	89536	269647	1		
5		Handle, carrying	231456	89536	231456	1		
6		Push button, gray	268896	71590	J52304	9		
7		Push button, green	268862	71590	J61993	1		
8		Shaft, switch extension	269688	89536	269688	9		
9		Shorting link	101220	24655	0938-9712	1		

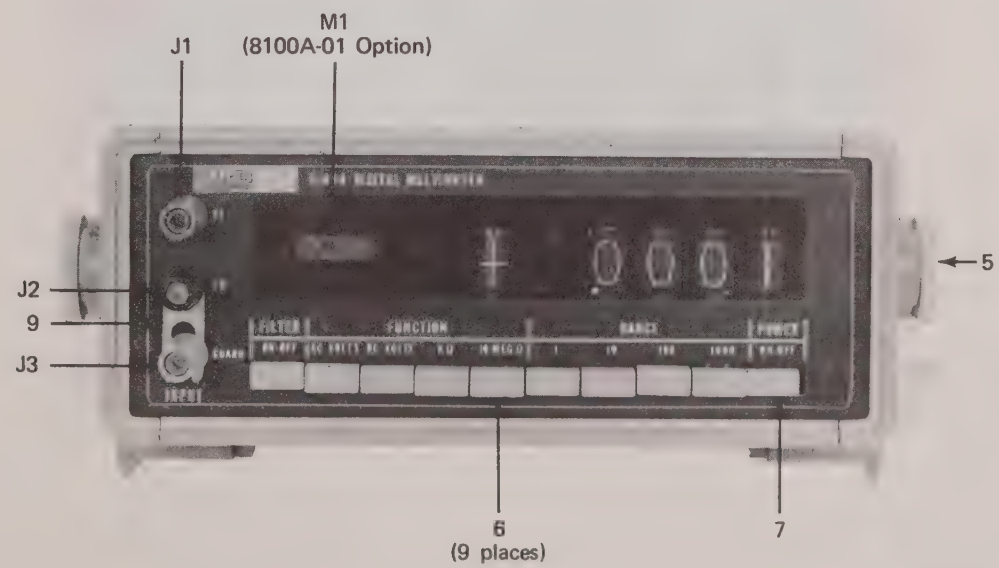


Figure 5-1. 8100A DIGITAL MULTIMETER (Sheet 1 of 2)

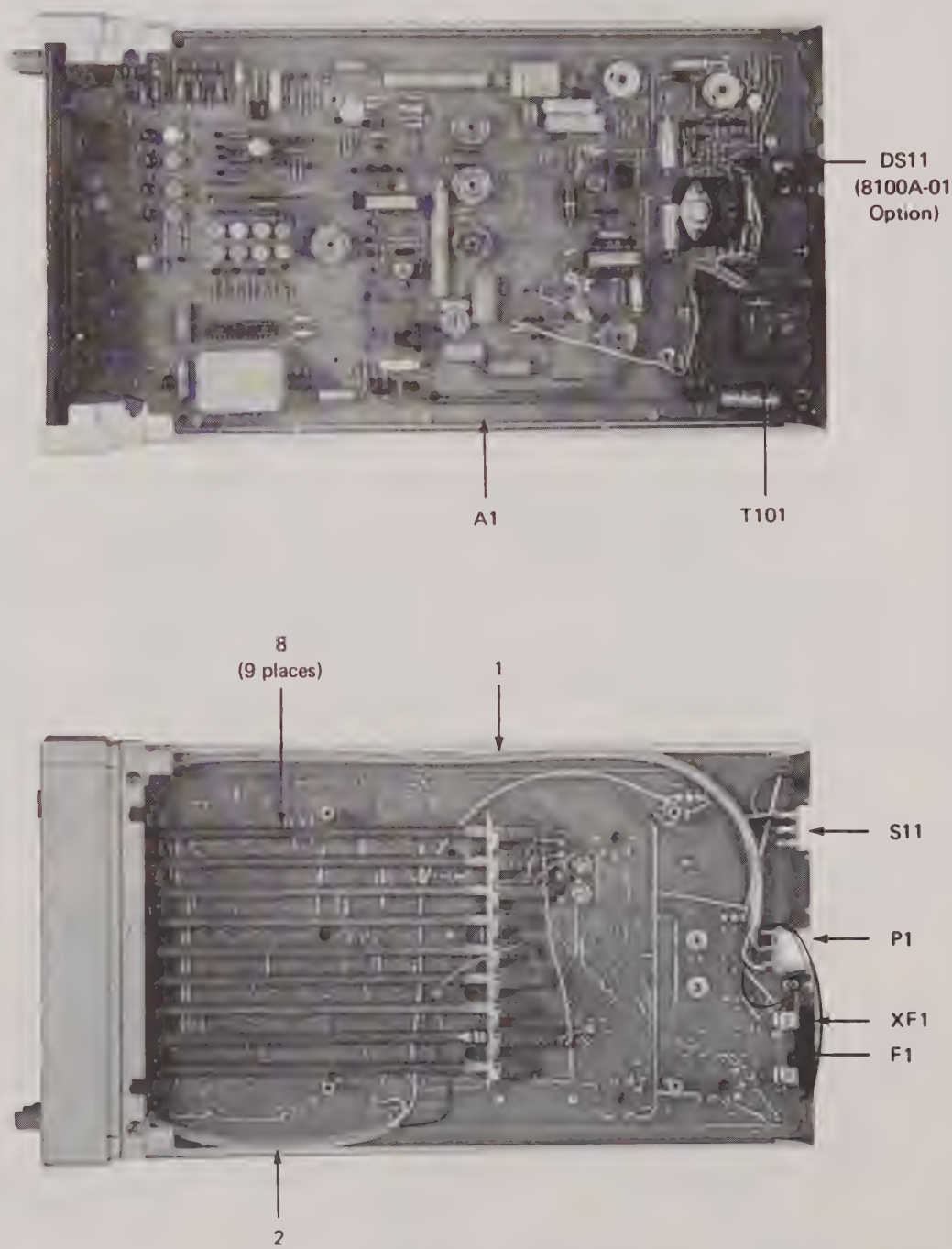


Figure 5-1. 8100A DIGITAL MULTIMETER (Sheet 2 of 2)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A1		**PRINTED CIRCUIT ASSEMBLY Figures 5-2 and 5-3**	269753	89536	269753	REF		
A1	G1-W2	IC, operational amplifier	268961	12040	SL6267	1	1	
A2	E1-R5	IC, operational amplifier	271502	12040	LM301A	1	2	
A3	C4-O5	IC, DTL, triple 3-input NAND gate	266312	04713	MC862P-6909	1		
A4	C4-N5	IC, DTL, Binary counter	267153	04713	MC839P-6921	1		
A5	C5-N1	IC, Decoder driver	267211	12040	DM8840N	1	1	
C1	B1-Z4	Cap, elect, 250 uf +50/−10%, 40v	178616	73445	C437ARG250	1	2	
C2	B3-R5	Cap, cer, 0.0012 uf ±10%, 500v	106732	71590	CF-122	2		
C3	F1-X5	Cap, elect, 50 uf +75/−10%, 25v	148650	06001	76F02KL500	2		
C4	C1-R5	Cap, plstc, 0.47 uf, factory selected	279422	89536	279422	1		
C5	F4-Z4	Cap, elect, 50 uf +50/−10%, 25v	168823	73445	C426ARF50	4		
C6	B4-N1	Cap, elect, 2 uf +50/−10%, 150v	267310	56289	30D205F150-BB4	1	1	
C7	H1-X5	Cap, elect, 50 uf +75/−10%, 25v	148650	06001	76F02KL500	REF		
C8	I4-Y3	Cap, elect, 50 uf +50/−10%, 25v	168823	73445	C426ARF50	REF		
C9	I3-V1	Cap, plstc, 0.22 uf ±10%, 1 kv	275495	84411	Type JF56	1		
C10	H2-V5	Cap, plstc, 0.1 uf ±20%, 120v	167460	84411	Type JF39	1		
C11	H4-U5	Cap, plstc, 0.033 uf ±10%, 250v	234492	73445	C280AE/A33K	2		
C12	H5-V4	Cap, plstc, 0.068 uf ±20%, 120v	260570	84411	Type JF39	1		
C13	H4-U4	Cap, plstc, 0.027 uf ±10%, 250v	267120	73445	C280AE/A27K	1		
C14	D4-V5	Cap, var, 0.5–5 pf, 500v	267914	72982	532-001	1		
C15	D1-V5	Cap, var, 1–8 pf, 500v	267906	72982	532-000	1		
C18	D3-X2	Cap, elect, 50 uf +50/−10%, 25v	168823	73445	C426ARF50	REF		
C19	E2-W4	Cap, plstc, 1.0 uf ±10%, 250v	190330	73445	C280AE/A1M	2		
C20	E5-W4	Cap, plstc, 0.22 uf ±10%, 250v	194803	73445	C280AE/A220K	2		
C21	I3-O2	Cap, elect, 5 uf +50/−10%, 64v	218966	73445	C426ARH5	1		
C22	I1-N3	Cap, plstc, 0.1 uf, factory selected	279430	89536	279430	5		
C23	I1-N1	Cap, plstc, 0.1 uf, factory selected	279430	89536	279430	REF		
C24	I1-M4	Cap, plstc, 0.1 uf, factory selected	279430	89536	279430	REF		
C25	I1-M1	Cap, plstc, 0.1 uf, factory selected	279430	89536	279430	REF		
C26	I1-N5	Cap, plstc, 0.1 uf, factory selected	279430	89536	279430	REF		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
C27	H4-O5	Cap, mica, 330 pf ±5%, 500v	148445	14655	CD15F331J	1		
C28	H4-O4	Cap, mica, 100 pf ±5%, 500v	148494	14655	CD15F101J	2		
C29	I1-P1	Cap, plstc, 0.47 uf ±10%, 250v	184366	73445	C280AE/A470K	1		
C30	H1-O2	Cap, plstc, 0.022 uf ±10%, 250v	234484	73445	C280AE/A22K	5		
C31	G5-O2	Cap, plstc, 0.022 uf ±10%, 250v	234484	73445	C280AE/A22K	REF		
C32	G4-O2	Cap, plstc, 0.022 uf ±10%, 250v	234484	73445	C280AE/A22K	REF		
C33	G2-O2	Cap, plstc, 0.022 uf ±10%, 250v	234484	73445	C280AE/A22K	REF		
C34	G5-O5	Cap, plstc, 0.047 uf ±20%, 120v	260562	84411	Type JF39	1		
C35	G5-P4	Cap, plstc, 0.1 uf ±10%, 250v	161992	73445	C280AE/A100K	4		
C36	E3-S1	Cap, mica, 33 pf ±5%, 500v	160317	14655	CD15E330J	3		
C37	F4-R4	Cap, plstc, 1.0 uf ±10%, 250v	190330	73445	C280AE/A1M	REF		
C38	C3-R4	Cap, cer, 0.0012 uf ±10%, 500v	106732	71590	CF-122	REF		
C39	C3-S2	Cap, mica, 470 pf ±5%, 500v	148429	14655	CD19F471J	1		A
C39	C3-S2	Cap, mica, 220 pf ±5%, 500v	237008	14655	CD19F221J	1		B
C42	C4-P4	Cap, plstc, 0.047 uf ±10%, 250v	162008	73445	C280AE/A47K	1		
C43	D1-P4	Cap, plstc, 0.033 uf ±10%, 250v	234492	73445	C280AE/A33K	REF		
C44	B2-Q3	Cap, elect, 50 uf + 50/−10%, 25v	168823	73445	C426ARF50	REF		
C45	E1-S2	Cap, mica, 47 pf ±5%, 500v	148536	14655	CD15E470J	2		
C46	F4-R1	Cap, mica, 47 pf ±5%, 500v	148536	14655	CD15E470J	REF		
C48	H4-S1	Cap, elect, 1 uf +75/−10%, 25v	165886	56289	30D105G-025BA4	1		
C50	C2-X2	Cap, plstc, 0.1 uf ±10%, 250v	161992	73445	C280AE/A100K	REF		
C51	G2-W4	Cap, mica, 150 pf ±5%, 500v	148478	14655	CD15F151J	1		
C52	G1-X1	Cap, mica, 33 pf ±5%, 500v	160317	14655	CD15E330J	REF		
C53	D5-W3	Cap, mica, 100 pf ±5%, 500v	148494	14655	CD15F101J	REF		
C54	I4-Q4	Cap, plstc, 0.22 uf ±10%, 250v	194803	73445	C280AE/A220K	REF		
C55	G4-N1	Cap, mica, 4 pf ±5%, 500v (Figure 5-2)	190397	14655	CD15C040K	1		
C57		Cap, mica, 33 pf ±5%, 500v	160317	14655	CD15E330J	REF		
C58		Cap, plstc, 0.1 uf ±10%, 250v	161992	73445	C280AE/A100K	REF		
C59		Cap, plstc, 0.022 uf ± 10%, 250v	234484	73445	C280AE/A22K	REF		
C60	D1-X5	Cap, cer, .001 uf ±20%, 3 kv	105635	56289	29C300	1		
C61	E4-U5	Cap, cer, 150 pf ±20%, 3 kv	277004	00656	HVD4150 ±20, 3 KV-2	1		
C62		Cap, plstc, 0.1 uf ±10%, 250v	161992	73445	C280AE/A100K	REF		
C63		Cap, factory selected	7					
CR1	B1-Y4	Diode, silicon, 1 amp, 100 piv	116111	05277	IN4817	7		
CR2	B1-Y3	Diode, silicon, 1 amp, 100 piv	116111	05277	IN4817	REF		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
CR3	B3-M4	Diode, silicon, 1 amp, 600 piv	112383	05277	1N4822	1		
CR4	D3-O2	Diode, silicon, 150 ma	203323	03508	DHD1105	10		
CR5	B3-R4	Diode, silicon, 1 amp, 100 piv	116111	05277	1N4817	REF		
CR6	B3-R2	Diode, silicon, 1 amp, 100 piv	116111	05277	1N4817	REF		
CR7	B4-P5	Diode, silicon, 1 amp, 100 piv	116111	05277	1N4817	REF		
CR8	B4-P3	Diode, silicon, 1 amp, 100 piv	116111	05277	1N4817	REF		
CR9	D3-O1	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
CR10	I3-Y2	Diode, silicon, 1 amp, 100 piv	116111	05277	1N4817	REF		
CR11	I1-W1	Diode, silicon, 10 ma, 2 piv	180554	07910	CD12599	2		
CR12	I1-W1	Diode, silicon, 10 ma, 2 piv	180554	07910	CD12599	REF		
CR13	I2-W1	Diode, silicon, 75 ma, 25 piv	241422	03508	1N4009	3		
CR14	F1-W3	Diode, silicon, 75 ma, 25 piv	241422	03508	1N4009	REF		
CR15	F1-X1	Diode, silicon, 75 ma, 25 piv	241422	03508	1N4009	REF		
CR16	G4-R3	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
CR17	H1-Q5	Diode, silicon, 200 ma, 25 piv	190272	93332	1N456A	4		
CR18	H1-S2	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
CR19	B4-Q5	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
CR20	D1-P4	Diode, silidon, 150 ma	203323	03508	DHD1105	REF		
CR23	D1-S1	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
CR26	E4-X1	Diode, silicon, 200 ma, 25 piv	190272	93332	1N456A	REF		
CR27	E4-W3	Diode, silicon, 200 ma, 25 piv	190272	93332	1N456A	REF		
CR29	D2-S1	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
CR30	D2-R1	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
CR35	G5-R3	Diode, silicon, 200 ma, 25 piv	190272	93332	1N456A	REF		
CR36	G1-P2	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
CR37	F1-X1	Diode, zener, 3.9v	113316	07910	1N748	1		
DS2	E3-K5	Lamp, Neon	266478	74276	A261	1	2	
F2	C2-Y2	Fuse, fast acting, ¼ amp, 250v	109314	71400	Type AGC	1		
Q1	F2-Y4	Tstr, silicon, NPN	183004	95303	40250	1	1	
Q2	H1-Y3	Tstr, silicon, PNP	195974	04713	2N3906	9		
Q3	H3-Y3	Tstr, silicon, PNP	195974	04713	2N3906	REF		
Q4	B3-S2	Tstr, silicon, NPN	272237	07263	2N4946	2	2	

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
Q5	B2-S4	Tstr, silicon, NPN	272237	07263	2N4946	REF		
Q6	G3-Z3	Tstr, silicon, PNP	195974	04713	2N3906	REF		
Q7	H1-Z3	Tstr, silicon, NPN	218396	04713	2N3904	11		
Q8	H3-Z3	Tstr, silicon, NPN	218396	04713	2N3904	REF		
Q9	H3-Y4	Tstr, silicon, PNP	195974	04713	2N3906	REF		
Q10	H3-Z1	Tstr, silicon, NPN	168716	07263	S19254	1		
Q11	H5-Z5	Tstr, factory selected & matched to R22	1					
Q12	G2-R4	Tstr, factory selected & matched to Q52	2					
Q13	H3-Q3	Tstr, FET, N-channel	255869	04713	2N5459	18	4	
Q14	H3-R1	Tstr, silicon, PNP	195974	04713	2N3906	REF		
Q15	H3-R3	Tstr, silicon, PNP	195974	04713	2N3906	REF		
Q16	G3-R5	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q17	G3-R2	Tstr, FET, N-channel	261578	15818	U1897E	1	2	
Q18	G2-Q5	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q19	I3-N5	Tstr, silicon, PNP, factory selected	281758	89536	281758	5	4	
Q20	I3-N3	Tstr, silicon, PNP, factory selected	281758	89536	281758	REF		
Q21	I3-N1	Tstr, silicon, PNP, factory selected	281758	89536	281758	REF		
Q22	I3-M4	Tstr, silicon, PNP, factory selected	281758	89536	281758	REF		
Q23	I3-M1	Tstr, silicon, PNP, factory selected	281758	89536	281758	REF		
Q24	I1-L5	Tstr, silicon, PNP	195974	04713	2N3906	REF		
Q25	I3-P3	Tstr, silicon, PNP	281741	89536	281741	1	1	
Q26	I3-P4	Tstr, silicon, PNP	195974	04713	2N3906	REF		
Q27	H1-P4	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q28	G3-P5	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q29	H1-P5	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q30	H1-N5	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q31	G5-N5	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q32	G4-N5	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q33	G3-N5	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q34	H1-O4	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q35	G3-O4	Tstr, FET, N-channel	255869	04713	2N5459	REF		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
Q36	H1-P1	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q37	G3-P1	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q38	H1-P2	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q39	G3-P2	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q40	F1-P2	Tstr, germanium, NPN	182691	01295	GA2875	4	2	
Q41	E3-P2	Tstr, germanium, PNP	182709	01295	GA2877	4	2	
Q42	E1-P2	Tstr, silicon, NPN	218396	04713	2N3904	REF		
Q43	F1-O5	Tstr, germanium, NPN	182691	01295	GA2875	REF		
Q44	E3-O5	Tstr, germanium, PNP	182709	01295	GA2877	REF		
Q45	E1-O5	Tstr, silicon, NPN	218396	04713	2N3904	REF		
Q46	F1-O2	Tstr, germanium, NPN	182691	01295	GA2875	REF		
Q47	E3-O2	Tstr, germanium, PNP	182709	01295	GA2877	REF		
Q48	E1-O2	Tstr, silicon, NPN	218396	04713	2N3904	REF		
Q49	F1-N5	Tstr, germanium, NPN	182691	01295	GA2875	REF		
Q50	E3-N5	Tstr, germanium, PNP	182709	01295	GA2877	REF		
Q51	E1-N5	Tstr, silicon, NPN	218396	04713	2N3904	REF		
Q52	E3-R2	Tstr, Factory selected & matched to Q12	2					
Q53	G1-R5	Tstr, FET, dual, N-channel	257501	17856	DN423	1	1	
Q54	D3-R2	Tstr, silicon, NPN	222869	03508	X16E2300	1	1	
Q58	F1-R2	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q59	C4-S1	Tstr, silicon, NPN	218396	04713	2N3904	REF		
Q60	C2-S1	Tstr, silicon, NPN	218396	04713	2N3904	REF		
Q61	D3-S1	Tstr, silicon, PNP	281766	89536	281766	2	1	
Q65	E2-M5	Tstr, FET, N-channel	255869	04713	2N5459	REF		
Q66	E1-M2	Tstr, silicon, NPN	245480	07263	S24496	3	1	
Q67	H1-M5	Tstr, silicon, NPN	218511	95303	60031	4	2	
Q68	G3-M5	Tstr, silicon, NPN	218511	95303	60031	REF		
Q69	F5-M5	Tstr, silicon, NPN	218511	95303	60031	REF		
Q70	F2-M5	Tstr, silicon, NPN	218511	95303	60031	REF		
Q71	H1-M2	Tstr, silicon, PNP	266619	07263	2N4888	4	2	
Q72	G3-M2	Tstr, silicon, PNP	266619	07263	2N4888	REF		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
Q73	F5-M2	Tstr, silicon, PNP	266619	07263	2N4888	REF		
Q74	F2-M2	Tstr, silicon, PNP	266619	07263	2N4888	REF		
Q75	G1-R2	Tstr, silicon, NPN	281766	89536	281766	REF		
Q76	E1-R2	Tstr, silicon, PNP	261032	04713	MPS404A	REF		
Q77	G4-W2	Tstr, FET, dual, N-channel	267963	17856	DN503	1	1	
Q79	F2-W2	Tstr, silicon, PNP	195974	04713	2N3906	REF		
Q80	F3-W4	Tstr, silicon, NPN	218396	04713	2N3904	REF		
Q81	F4-L2	Tstr, silicon, NPN	245480	07263	S24496	REF		
Q82	G1-L1	Tstr, silicon, NPN	245480	07263	S24496	REF		
Q83	E4-R2	Tstr, silicon, NPN	218396	04713	2N3904	REF		
R1	D5-Y3	Res, comp, 470Ω ±10%, 1w	109710	01121	GB4711	1		
R2	G4-Y3	Res, comp, 1k ±5%, ¼w	148023	01121	CB1025	5		
R3	G4-Y3	Res, comp, 33k ±5%, ¼w	148155	01121	CB3335	2		
R4	G4-Y2	Res, met flm, 38.3k ±1%, 1/8w	241372	91637	Type MFF1/8	1		
R5	H2-Y1	Res, met flm, 34k ±1%, 1/8w	261602	91637	Type MFF1/8	4		
R6	B4-R1	Res, met flm, 14.7k ±1%, 1/8w	226225	91637	Type MFF1/8	5		
R7	B5-S2	Res, met flm, 14.7k ±1%, 1/8w	226225	91637	Type MFF1/8	REF		
R8	B5-R1	Res, comp, 220k ±5%, ¼w	160937	01121	CB2245	5		
R9	G3-Z4	Res, comp, 1k ±5%, ¼w	148023	01121	CB1025	REF		
R10	G4-Y4	Res, comp, 270Ω ±5%, ¼w	160804	01121	CB2715	2		
R11	G4-Z2	Res, comp, 1k ±5%, ¼w	148023	01121	CB1025	REF		
R12	G4-Z1	Res, comp, 100k ±5%, ¼w	148189	01121	CB1045	1		
R13	H2-Z5	Res, met flm, 12.1k ±1%, 1/8w	234997	91637	Type MFF 1/8	1		
R14	H2-Z4	Res, met flm, 2.94k ±1%, 1/8w	261628	91637	Type MFF 1/8	1		
R15	G4-Y5	Res, met flm, factory matched to Q11	1					
R16	G4-Y4	Res, comp, 47k ±5%, ¼w	148163	01121	CB4735	7		
R17	G4-Z1	Res, comp, 3.3k ±5%, ¼w	148056	01121	CB3325	6		
R18	I3-AA2	Res, met flm, 10k ±1%, 1/8w	168260	91637	Type MFF 1/8	1		
R19	I3-AA1	Res, comp, 3.3k ±5%, ¼w	148056	01121	CB3325	REF		
R20	I3-Z4	Res, met flm, 412Ω ±1%, 1/8w	261636	91637	Type MFF 1/8	1		
R21	I3-Z5	Res, met flm, 19.1k ±1%, 1/8w	234963	91637	Type MFF 1/8	3		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R22	I3-Z5	Res, met flm, factory selected and matched to Q11	1					
R23	I1-Z2	Res, var, ww, 10k ±10%, 2w	272740	71450	Type 115	3		
R24	I2-S4	Res, met flm, 1M ±0.1%, 2w	225953	03888	Type PME80	1		
R27	F4-V4	Res, comp, 1M ±10%, 2w	268227	01121	HB1051	1		
R28	G3-V4	Res, comp, 1.2M ±5%, ¼w	188425	01121	CB1255	1		
R29	G4-N2	Res, met flm, 449.1k, matched (Figure 5–2)	3					
R30	G4-M5	Res, met flm, 49.9k, matched (Figure 5–2)	3					
R31	G4-M5	Res, met flm, 4.99k, matched (Figure 5–2)	3					
R32	G4-M4	Res, met flm, 499Ω, matched (Figure 5–2)	3					
R34	C3-W5	Res, var, ww, 10k ±10%, 2w	272740	71450	Type 115	REF		
R35	E3-X1	Res, comp, 220k ±5%, ¼w	160937	01121	CB2245	REF		
R36	E3-W2	Res, comp, 820k ±5%, ¼w	220541	01121	CB8245	1		
R37	G4-S2	Res, comp, 220k ±5%, ¼w	160937	01121	CB2245	REF		
R39	G5-Q3	Res, comp, 18k ±5%, ¼w	148122	01121	CB1835	1		
R40	H5-S2	Res, met flm, 14.7k ±1%, 1/8w	226225	91637	Type MFF 1/8	REF		
R42	H5-R2	Res, met flm, 499k ±1%, 1/8w	268813	91637	Type MFF 1/8	2		
R43	H1-R3	Res, met flm, 499k ±1%, 1/8w	268813	91637	Type MFF 1/8	REF		
R45	G5-Q5	Res, comp, 22k ±5%, ¼w	148130	01121	CB2235	8		
R46	H2-S2	Res, comp, 22k ±5%, ¼w	148130	01121	CB2235	REF		
R47	H3-S2	Res, met flm, 14.7k ±1%, 1/8w	226225	91637	Type MFF 1/8	REF		
R48	G1-T4	Res, var, ww, 200Ω ±20%, 1-¼w	144766	71450	Type 110	1		
R49	G3-T2	Res, ww, 6.45k ±0.5%, ½w	184416	89536	184416	1		
R50	H2-T4	Res, var, ww, 15Ω ±20%, 1-¼w	163634	71450	Type 110	1		
R51	G5-T2	Res, ww, 2.85k ±0.1%, ½w	253450	89536	253450	1		
R52	G5-S2	Res, comp, 220k ±5%, ¼w	160937	01121	CB2245	REF		
R53	H5-O3	Res, comp, 3.3k ±5%, ¼w	148056	01121	CB3325	REF		
R54	I4-O3	Res, comp, 1k ±5%, ¼w	148023	01121	CB1025	REF		
R56	I4-N5	Res, comp, 47k ±5%, ¼w	148163	01121	CB4735	REF		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R57	I4-N3	Res, comp, 47k ±5%, ¼w	148163	01121	CB4735	REF		
R58	I4-M5	Res, comp, 47k ±5%, ¼w	148163	01121	CB4735	REF		
R59	I4-M3	Res, comp, 47k ±5%, ¼w	148163	01121	CB4735	REF		
R60	I4-L5	Res, comp, 47k ±5%, ¼w	148163	01121	CB4735	REF		
R61	I4-M1	Res, met flm, 200k ±1%, 1/8w	261701	91637	Type MFF 1/8	2		
R62	I1-O1	Res, comp, 22k ±5%, ¼w	148130	01121	CB2235	REF		
R63	I1-N4	Res, comp, 22k ±5%, ¼w	148130	01121	CB2235	REF		
R64	I1-N2	Res, comp, 22k ±5%, ¼w	148130	01121	CB2235	REF		
R65	I1-M5	Res, comp, 22k ±5%, ¼w	148130	01121	CB2235	REF		
R66	H5-M3	Res, comp, 22k ±5%, ¼w	148130	01121	CB2235	REF		
R67	H5-M3	Res, comp, 270k ±5%, ¼w	220061	01121	CB2745	1		
R68	I2-O5	Res, comp, 150k ±5%, ¼w	182212	01121	CB1545	2		
R69	I2-O4	Res, comp, 470k ±5%, ¼w	188441	01121	CB4745	2		
R70	H5-P4	Res, comp, 150k ±5%, ¼w	182212	01121	CB1545	REF		
R71	H5-Q1	Res, comp, 22k ±5%, ¼w	148130	01121	CB2235	REF		
R72	H5-P3	Res, comp, 1.5M ±5%, ¼w	182857	01121	CB1555	2		
R73	H5-P3	Res, comp, 47k ±5%, ¼w	148163	01121	CB4735	REF		
R74	H5-P5	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	14		
R75	F4-Q2	Res, met flm, 8.66k ±1%, 1/8w	260364	91637	Type MFF 1/8	1		
R77	G1-O1	Res, ww, 3.4483k, matched	4					
R78	F4-O5	Res, met flm, 422k ±1%, 1/8w	276626	91637	Type MFF 1/8	1		
R79	F5-P3	Res, ww, 200k, matched	4					
R80	D4-P3	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R81	D4-P2	Res, comp, 15k ±5%, ¼w	148114	01121	CB1535	5		
R82	D4-P3	Res, comp, 1.6k ±5%, ¼w	266197	01121	CB1625	6		
R83	F2-P1	Res, met flm, 232k ±1%, 1/8w	276618	91637	Type MFF 1/8	REF		
R84	F3-O4	Res, ww, 100k, matched	4					
R85	D4-O5	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R86	D4-O5	Res, comp, 15k ±5%, ¼w	148114	01121	CB1535	REF		
R87	D4-P1	Res, comp, 1.6k ±5%, ¼w	266197	01121	CB1625	REF		
R88	F3-O1	Res, met flm, 121k ±1%, 1/8w	229369	91637	Type MFF 1/8	2		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R89	F4-O2	Res, ww, 50k, matched	4					
R90	D4-O3	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R91	D4-O2	Res, comp, 15k ±5%, ¼w	148114	01121	CB1535	REF		
R92	D4-O4	Res, comp, 1k ±5%, ¼w	148023	01121	CB1025	REF		
R93	F2-O1	Res, met flm, 121k ±1%, 1/8w	229369	91637	Type MFF 1/8	REF		
R94	F3-O1	Res, ww, 50k, matched	4					
R95	D4-N5	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R96	D4-N4	Res, comp, 15k ±5%, ¼w	148114	01121	CB1535	REF		
R97	D4-N5	Res, comp, 1.6k ±5%, ¼w	266197	01121	CB1625	REF		
R98	F2-P4	Res, ww, 200k, matched	4					
R99	G2-P4	Res, met flm, 11.8k ±1%, 1/8w	277145	91637	Type MFF 1/8	1		
R100	G2-P3	Res, met flm, 2k ±1%, 1/8w	277137	91637	Type MFF 1/8	1		
R101	H5-R2	Res, met flm, 19.1k ±1%, 1/8w	234963	91637	Type MFF 1/8	REF		
R102	E4-S1	Res, met flm, 34k ±1%, 1/8w	261602	91637	Type MFF 1/8	REF		
R103	E4-S1	Res, met flm,34k ±1%, 1/8w	261602	91637	Type MFF 1/8	REF		
R104	E3-R4	Res, met flm, 45.3k ±1%, 1/8w	234971	91637	Type MFF 1/8	1		
R108	D2-R2	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	3		
R110	D5-S1	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R111	H2-S2	Res, met flm, 19.1k ±1%, 1/8w	234963	91637	Type MFF 1/8	REF		
R112	H4-R2	Res, comp, 2.2M ±5%, ¼w	198390	01121	CB2255	1		
R116	H5-Q1	Res, comp, 180k ±5%, ¼w	193441	01121	CB1845	9		
R118	D4-S1	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R119	C4-R2	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R120	C2-R2	Res, comp, 33k ±5%, ¼w	148155	01121	CB3335	REF		
R121	C3-R2	Res, comp, 2.2k ±5%, ¼w	148049	01121	CB2225	5		
R122	D4-R2	Res, comp, 2.2k ±5%, ¼w	148049	01121	CB2225	REF		
R123	D5-R2	Res, comp, 82k ±5%, ¼w	188458	01121	CB8235	1		
R124	D1-R2	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
R127	F2-M3	Res, comp, 22k ±5%, ¼w	148130	01121	CB2235	REF		C
R127	F2-M3	Res, comp, 12k ±5%, ¼w	159731	01121	CB1235	2		D
R128	E2-M4	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R130	E4-M3	Res, comp, 62k ±5%, ¼w	220053	01121	CB6235	1		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R131	H3-N2	Res, comp, 180k ±5%, ¼w	193441	01121	CB1845	REF		
R132	G5-M3	Res, comp, 180k ±5%, ¼w	193441	01121	CB1845	REF		
R133	G5-N2	Res, comp, 180k ±5%, ¼w	193441	01121	CB1845	REF		
R134	G2-M3	Res, comp, 180k ±5%, ¼w	193441	01121	CB1845	REF		
R135	G2-N2	Res, comp, 180k ±5%, ¼w	193441	01121	CB1845	REF		
R136	F4-M3	Res, comp, 180k ±5%, ¼w	193441	01121	CB1845	REF		
R137	F4-N2	Res, comp, 180k ±5%, ¼w	193441	01121	CB1845	REF		
R138	F1-M3	Res, comp, 180k ±5%, ¼w	193441	01121	CB1845	REF		
R139	E5-N1	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
R140	E5-N1	Res, comp, 3.9k ±5%, ¼w	148064	01121	CB3925	1		
R141	G5-M3	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R142	G2-M3	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R143	F4-M3	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R144	E5-M3	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R145	E4-M3	Res, comp, 1.1k ±5%, ¼w	267336	01121	CB1125	1		
R146	C3-P4	Res, comp, 1.6k ±5%, ¼w	266197	01121	CB1625	REF		
R147	C5-P4	Res, comp, 1.6k ±5%, ¼w	266197	01121	CB1625	REF		
R149	E4-Q3	Res, var, ww, 500Ω ±10%, 1-¼w	112433	71450	Type 110	1		
R152	F2-T3	Res, met flm, 200k ±1%, 1/8w	261701	91637	Type MFF1/8	REF		
R153	E4-T4	Res, var, ww, 10k ±10%, 2w	272740	71450	Type 115	REF		
R154	F3-T3	Res, met flm, 34k ±1%, 1/8w	261602	91637	Type MFF 1/8	REF		
R155	B3-R4	Res, comp, 15Ω ±5%, ¼w	147876	01121	CB1505	1		
R156	E4-S5	Res, met flm, 8.987M ±0.1%, 2w	261453	03888	Type PME80	1	1	
R157	C5-T1	Res, var, comp, 35k ±30%, ¼w	272229	71450	UL5120	1		
R158	C2-T2	Res, ww, 900k, matched	5				1 SET	
R159	B5-U3	Res, ww, 90k, matched	5					
R160	D3-T5	Res, ww, 10k, matched	5					
R161	D3-W4	Res, met flm, 14.7k ±1%, 1/8w	226225	91637	Type MFF 1/8	REF		
R162	D3-W5	Res, met flm, 1.18k ±1%, 1/8w	268409	91637	Type MFF 1/8	1		
R163	G4-X1	Res, met flm, 35k ±0.1%, 1/8w	229443	91637	Type MFF 1/8	2		
R164	G3-X1	Res, met flm, 35k ±0.1%, 1/8w	229443	91637	Type MFF 1/8	REF		
R165	H2-X3	Res, met flm, 46.4k ±1%, 1/8w	188375	91637	Type MFF 1/8	1		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R166	F4-X1	Res, comp, 12k ±5%, ¼w	159731	01121	CB1235	REF		
R169	F4-W2	Res, comp, 270Ω ±5%, ¼w	160804	01121	CB2715	REF		
R170	F1-W2	Res, comp, 15k ±5%, ¼w	148114	01121	CB1535	REF		
R172	F5-X1	Res, comp, 3.3k ±5%, ¼w	148056	01121	CB3325	REF		
R174	E1-W4	Res, met flm, 453Ω ±1%, 1/8w	267393	91637	Type MFF 1/8	1		
R175	I2-W5	Res, var, ww, 10Ω ±10%, 2w	183921	71450	Type 115	1	1	
R176	I2-X3	Res, met flm, 28.7Ω ±1%, 1/8w	272823	91637	Type MFF 1/8	1		
R177	H2-W5	Res, met flm, 13.7Ω ±1%, 1/8w	272815	91637	Type MFF 1/8	1		
R179	F4-X1	Res, comp, 3.3k ±5%, ¼w	148056	01121	CB3325	REF		
R180	F2-S1	Res, comp, 470k ±5%, ¼w	188441	01121	CB4745	REF		
R181	I1-Y3	Res, comp, 3.3k ±5%, ¼w	148056	01121	CB3325	REF		
R184	E5-R2	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R185	E5-S1	Res, comp, 1.5M ±5%, ¼w	182857	01121	CB1555	REF		
R186	G2-Q3	Res, comp, factory selected	6					
R187	G1-Q5	Res, comp, 3.3Ω ±5%, ¼w	182279	01121	CB33G5	1		
R188	G5-Q4	Res, comp, 2.2k ±5%, ¼w	148049	01121	CB2225	REF		
R189	H1-R3	Res, comp, 2.2k ±5%, ¼w	148049	01121	CB2225	REF		
R191	G2-O4	Res, comp, 220k ±5%, ¼w	160937	01121	CB2245	REF		
R193	H2-X2	Res, comp, 6.2Ω ±5%, ¼w	272831	01121	CB62G5	1		
R194		Res, comp, 1.6k ±5%, ¼w	266197	01121	CB1625	REF		
R195		Res, comp, 470Ω ±5%, ¼w	147983	01121	CB4715	2		
R196		Res, comp, 470Ω ±5%, ¼w	147983	01121	CB4715	REF		
R197	I3-Q2	Res, comp, 27Ω ±5%, ¼w	160812	01121	CB2705	1		
R198		Res, comp, 2.2k ±5%, ¼w	148049	01121	CB2225	REF		
S1 thru S10	A4-M4	Switch assembly, front, S1 – S10	279406	89536	279406	1	1	
	F4-M4	Switch assembly, rear, S1 – S10 (Figure 5-2)	279448	89536	279448	1	1	
T102	B3-O3	Transformer, inverter	253583	89536	253583	1	1	
V1	D5-K4	Tube, Nixie®, 0-9 readout	266502	89594	B-5750S	4	4	
V2	D2-K4	Tube, Nixie®, 0-9 readout	266502	89594	B-5750S	REF		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
V3	C3-K4	Tube, Nixie®, 0-9 readout	266502	83594	B-5750S	REF		
V4	B5-K4	Tube, Nixie®, 0-9 readout	266502	83594	B-5750S	REF		
V5	F1-K4	Tube, polarity indicator	272922	83594	B-5856ST	1	1	
XA3, XA4	C5-O1	Socket, IC, 14 contact	276527	23880	TSA-2900-14W	2		
XA5	D1-N2	Socket, IC, 16 contact	276535	23880	TSA-2900-16W	1		
XDS2	B3-L2	Socket, lamp	279372	89536	279372	1		
XV1 thru XV5	D3-L2	Socket, tube	268714	83594	SK207	5		
	B3-V1	Cable, guard	279414	89536	279414	1		
		Cover, tube (not illustrated)	279364	89536	279364	1		
	F5-Y5	Heat sink	186759	89536	186759	1		

[1] ~ Q11 and R22 are a matched set and must be replaced as a set. For replacement, order Reference-Amplifier Set, part number 269803.

[2] ~ Q12 and Q52 are a J-FET matched set and must be replaced as a set. For replacement, order part number 265744.

[3] ~ R29 thru R32 are a matched set and must be replaced as a set. For replacement, order AC Converter Resistor Set, part number 257014.

[4] ~ R77, R79, R84, R89, R94 and R98 are a matched Ladder Divider Resistor Set, part number 269795. However, the resistors may be replaced individually if model, serial number, full reference designation and all information stamped on the old resistor are included when ordering a new one.

[5] ~ R158, R159 and R160 are a matched set and must be replaced as a set. For replacement, order Input Divider Resistor Set, part number 269787.

[6] ~ R188 is factory selected. For replacement, replace with exact value.

[7] ~ C63 is factory selected. Not present on some units.

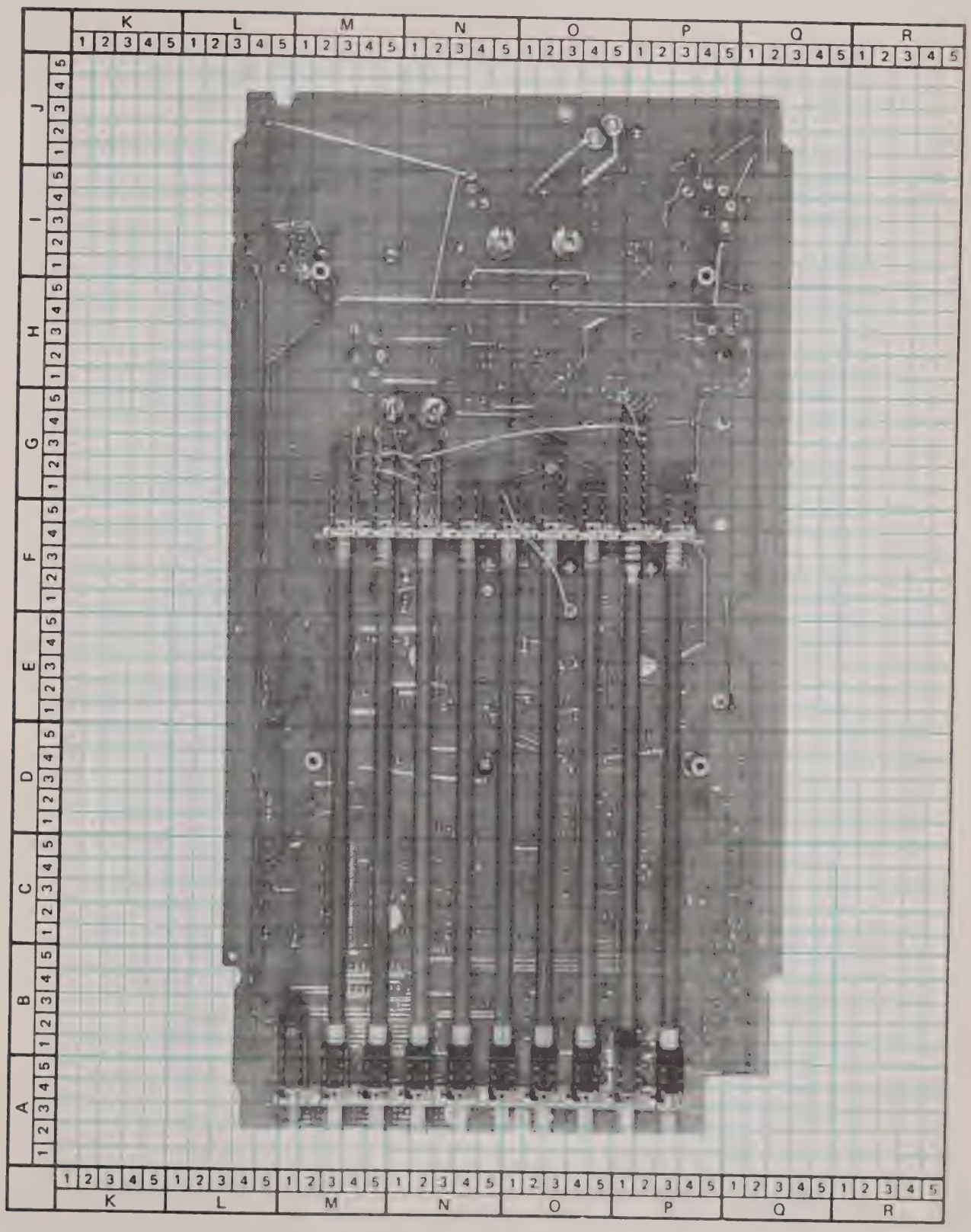


Figure 5-2. PRINTED CIRCUIT ASSEMBLY

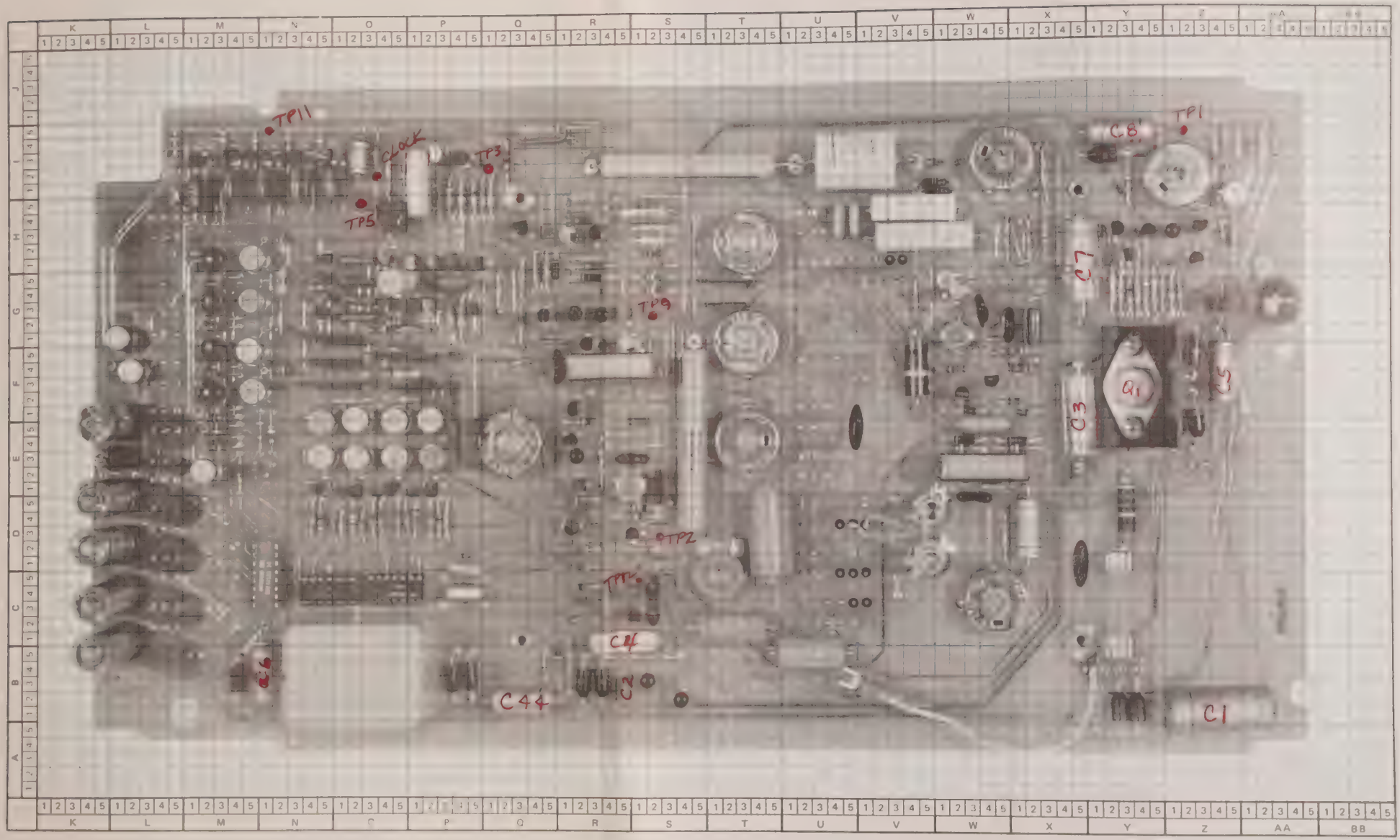


Figure 5-3. PRINTED CIRCUIT ASSEMBLY

5-9. SERIAL NUMBER EFFECTIVITY

5-10. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the Model 8100A. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List below. All parts with no code are used on all instruments with serial numbers above 123.

USE CODE	SERIAL NUMBER EFFECTIVITY
NONE	Model 8100A serial number 123 and on.
A	Model 8100A serial numbers 123, 132, 133, 136, 138, 140, 143-145, 148, 152-156, 160, 164, 166, 171 and on.
B	Model 8100A serial numbers 124-131, 134, 135, 137, 139, 141, 142, 146, 147, 149-151, 157-159, 161-163, 165, 167-170.
C	Model 8100A serial numbers 123 to approximately serial number 400.
D	Model 8100A approximately serial number 400 and on.

SECTION VI

ACCESSORIES AND OPTIONS

6-1. INTRODUCTION

6-2. This section of the manual contains information pertaining to the accessories and options which are available for the Model 8100A Digital Multimeter. Accessory information consists of a brief description of the accessory and its specifications. Option information is designated by the option number, which is printed in the top corner of each page. Option information includes the field installation procedure, operating instructions, and list of replaceable parts.

6-3. ACCESSORIES

6-4. High Frequency Probe

6-5. The High Frequency Probe (Fluke Model 80-RF) converts the Model 8100A into a high frequency ac voltmeter. The probe is used for ac voltage measurements of 0.25 volts to 30 volts over a frequency range of 100 kHz to 500 MHz. The accuracy of measurement is ±5% from 100 kHz to 100 MHz and ±7% to 500 MHz over a temperature range of +10°C to +30°C. The probe operates into any dc voltmeter with an input resistance of 10 megohms ±10%. The shielded dual-banana plug on the probe permits direct connection to voltmeter input. Additional specifications for the probe are listed in Figure 6-1.

6-6. High Voltage Probes

6-7. The 80F-5 and 80F-15 Voltage Dividers (Figure 6-2) are designed for use with the Model 8100A Digital Multimeter. Full-scale input for the Model 80F-5 is 5000 volts dc and for the Model 80F-15 is 15,000 volts dc. In use, the dividers simply plug in to the Model 8100A input terminals, and high voltage connection is made using the attached probe. Figure 6-3 gives the specifications for both dividers.

VOLTAGE RANGE: 0.25V to 30V.

RESPONSE: Responds to peak value of input. Calibrated to read rms value of a sine wave input.

AC to DC TRANSFER ACCURACY:

Loaded with 10 megohm ±10%.

	100 kHz	100 MHz	500 MHz
+10°C to +30°C	±5%	±7%	
−10°C to +40°C	±7%	±15%	

<±3 db at 10 kHz and 700 MHz.

INPUT IMPEDANCE: 4 megohms shunted by 2 ±0.5 pf.

MAXIMUM INPUT: 30 volts rms AC, 200 volts DC.

CABLE CONNECTION: Shielded dual banana plug Fits all standard 3/4-inch dual banana connectors.

CABLE LENGTH: 4 ft (121.9 cm) minimum.

WEIGHT: 3-½ oz net.

ACCESSORIES SUPPLIED: Ground Lead
Straight Tip
Hook Tip
High Frequency Adapter

Figure 6-1. HIGH FREQUENCY PROBE CHARACTERISTICS

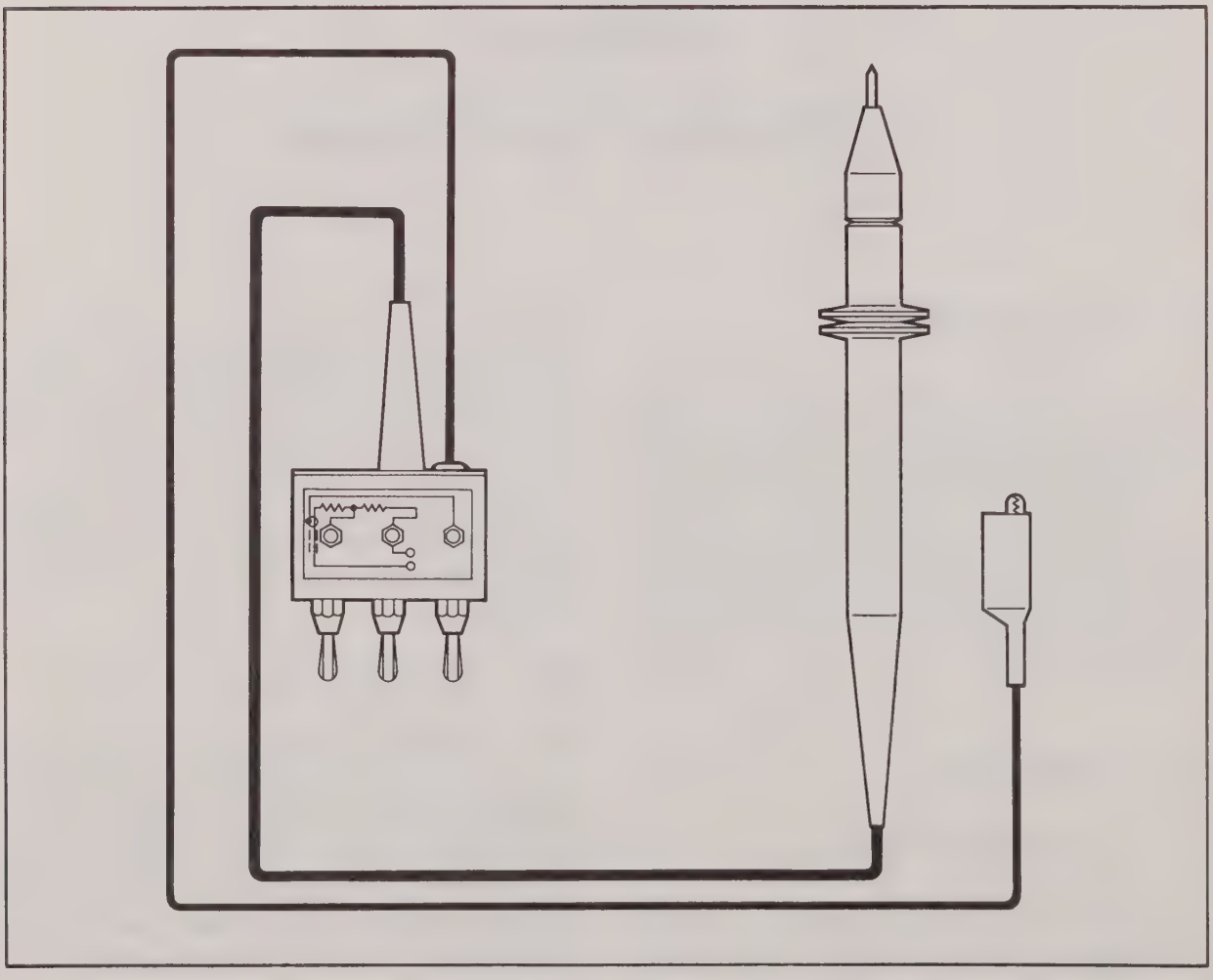


Figure 6-2. MODEL 80F-5/80F-15 HIGH VOLTAGE PROBES

PARAMETER	SPECIFICATIONS	
	MODEL 80F-5	MODEL 80F-15
Ratio Accuracy	±0.01% of input from 500 to 5000 vdc.	±0.01% of input from 1000 to 15,000 vdc.
Stability of Ratio	±0.01% per month, ±0.05% per year (recalibrated by internal adjustment)	
Temperature Coefficient	0.001%/°C	
Voltage Coefficient	< 20 ppm total from 0 to 5000 vdc	< 20 ppm total from 0 to 15,000 vdc
Division Ratio	1000 : 1	
Maximum Input Voltage	5000 vdc	15,000 vdc
Input Impedance	50 MΩ	100 MΩ
Operating Temperature Range	0°C to 50°C.	
Humidity Range	0 to 80%	
Altitude Range	Operating: 0 to 10,000 ft. Non-operating: 0 to 50,000 ft.	
Weight	12 oz.	24 oz.

Figure 6-3. VOLTAGE DIVIDER SPECIFICATIONS

6-8. Switched AC/DC Current Shunts

6-9. The Model A90 Current Shunt (Figure 6-4) enables the Model 8100A to be used for ac and dc current measurements to 10 amperes. The Model A90 is supplied in half-rack case to match the Model 8100A. The instruments may be conveniently mounted together in a 19-inch rack, with the Model A90 output terminals adjacent to the Model 8100A input terminals. The Model A90 provides six full-scale ranges as follows: 0.1, 1, 10, 100, and 1000 milliamps and 10 amperes (ac or dc). Full-scale input on any Model A90 range provides 100 millivolts dc to the input of the Model 8100A.

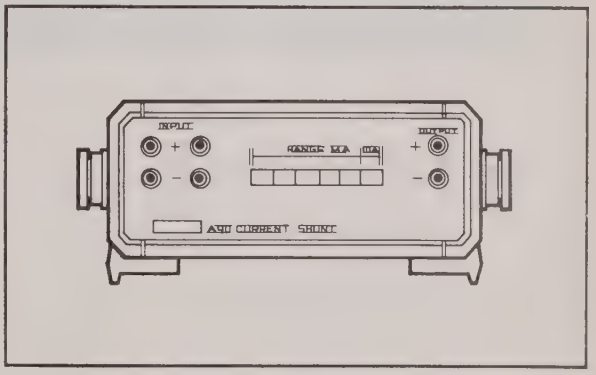


Figure 6-4. MODEL A90 CURRENT SHUNT

6-10. Front Panel Dust Cover

6-11. The vacuum-formed dust cover (Figure 6-5) attaches to the front of the Model 8100A. It prevents accumulation of dust on the front panel when the instrument is not in use and it affords added protection for the instrument when it is in transit. The Fluke number for the dust cover is 252205.

6-12. Rack Mount Kits

6-13. There are two rack mount kits available for the Model 8100A. One kit (No. 243287) allows two Model 8100A multimeters to be mounted side-by-side in a standard 19 inch rack, as shown in Figure 6-6. The two instruments are connected together at the center of the rack by two number 10 machine screws (not supplied). Holes for these screws are located in the front casting and are accessible after removing the decal at the side of the casting. The rack ears fasten to the front casting at either side, and are each held in place by two existing screws located under the decal. The second kit (No. 256594) supplies the hardware necessary to mount one Model 8100A in the center of the rack. In this case the rack ears are proportionally longer to permit center mounting.

Figure 6-5. FRONT PANEL DUST COVER

6-14. OPTION INFORMATION

6-15. Introduction

6-16. The rechargeable battery pack (Option-01) may be factory installed when the instrument is first purchased or it may be purchased separately and installed at a later time. The kit consists of a battery, a ballast lamp, two resistors, three diodes, a charge indication meter and associated hardware. The following paragraphs give the field installation procedure, operating instructions, and list of replaceable parts for the battery option.

6-17. Installation Procedure

a. Disconnect the instrument from the line.

b. Remove the top and bottom dust covers, the narrow trim strips just above and below the readout tubes, and the top and bottom guard chassis; use the procedure given in Section IV, paragraph 4-9 of the manual.

c. Install and solder the 2 ohm and 11.5k resistors on the PCB at the locations shown in Figure 6-7.

CAUTION

Use a 40-watt soldering iron and non-corrosive solder on all connections.

d. Install and solder the three diodes on the PCB at the locations shown in Figure 6-7. Be sure that the diodes are oriented according to the anode-cathode markings that are etched on the PCB.

e. Install and solder the ballast lamp on the PCB at the location shown in Figure 6-7. Three solder connections are required: The anchor lug on the component side of the PCB should be soldered to the side of the lamp base once the lamp is in position, and the two lamp terminals should be soldered from the underneath side of the PCB.

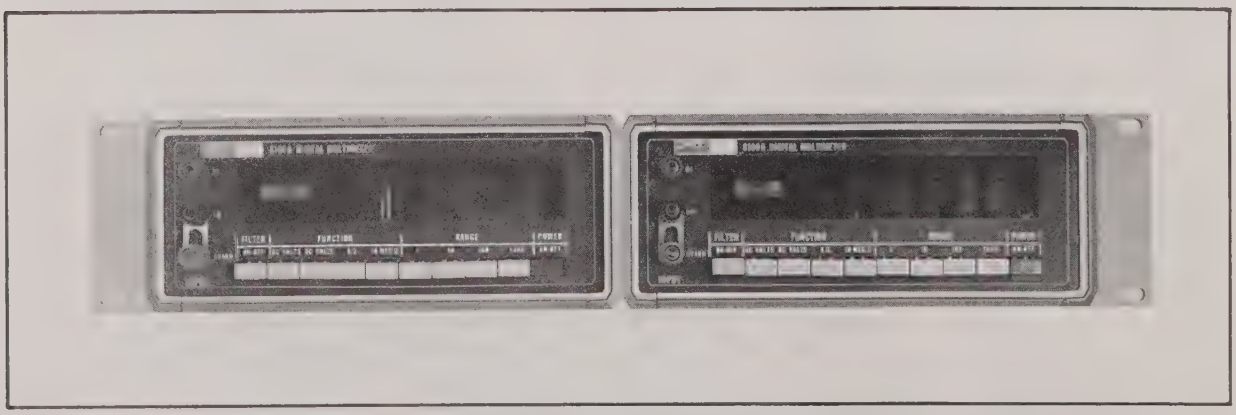


Figure 6-6. RACK MOUNT KIT

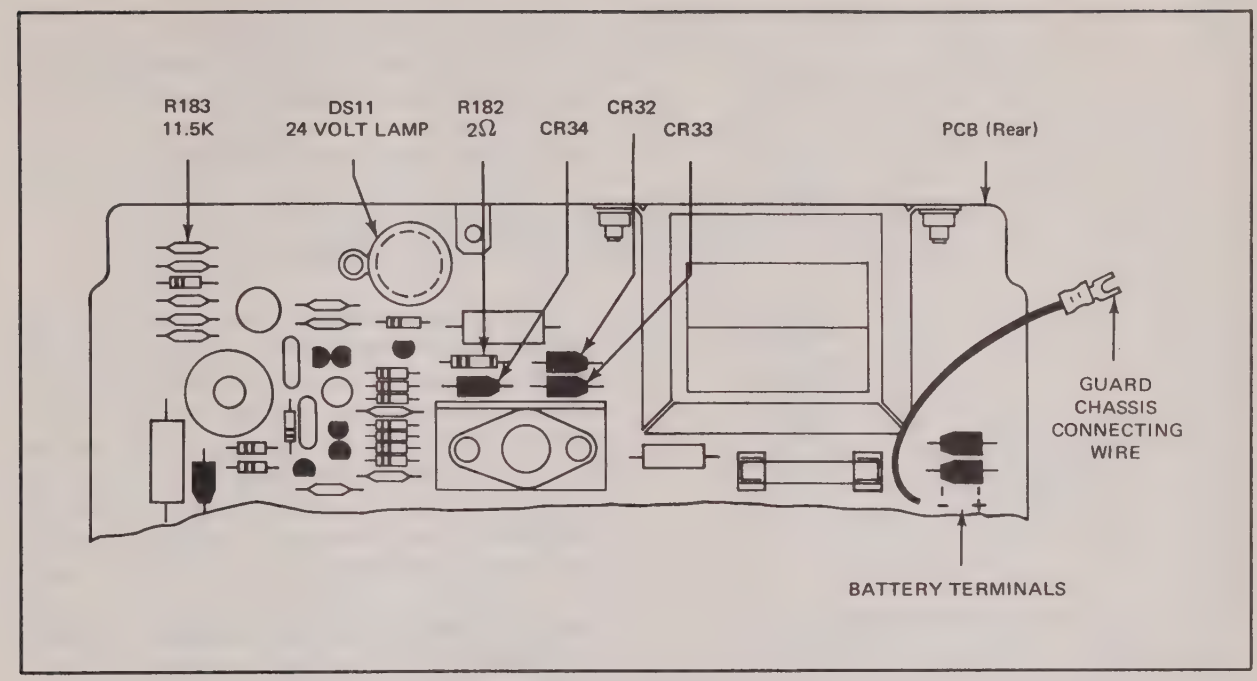


Figure 6-7. COMPONENT LOCATIONS FOR MODEL 8100A BATTERY OPTION INSTALLATION

f. Refer to Figure 6-8 and install the meter by performing the following steps:

1. Remove the nut and washer which fasten the black tube cover to the inside of the front panel assembly near the INPUT terminals.

2. Bend the meter portion of the cover away from the panel far enough to allow the meter to be placed inside the cover, with the meter face in position against the panel.

3. Fasten the cover in place by replacing the nut and washer.

4. Bend the meter lugs so they are parallel with the PCB.

5. Using a length of the tinned copper wire, connect and solder the left meter lug (viewed from rear) to the hole in the PCB which is located just below the lug (see Figure 6-8). In like manner, connect and solder the right meter lug to the right-hand hole.

g. Install the battery pack on the underneath side of the top guard chassis, using the battery pack holder and the six machine screws (Figure 6-9). Orient the battery pack so the battery leads pass through the grommeted hole in the side of the guard chassis.

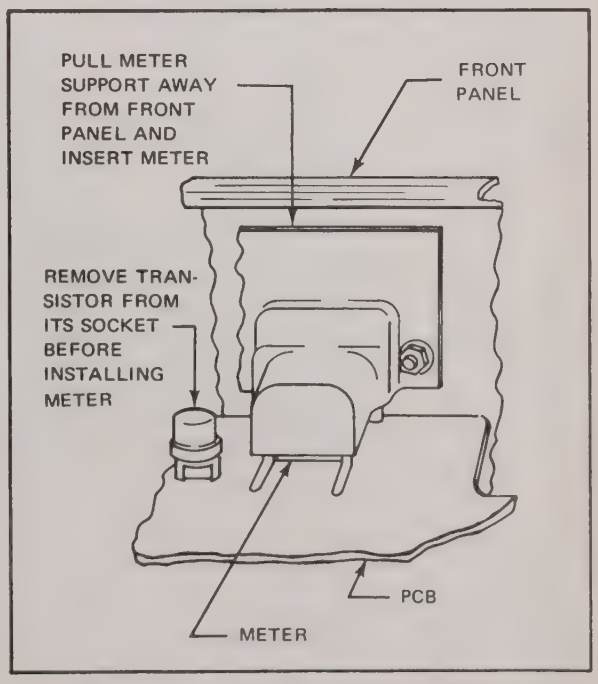


Figure 6-8. BATTERY OPTION METER INSTALLATION.

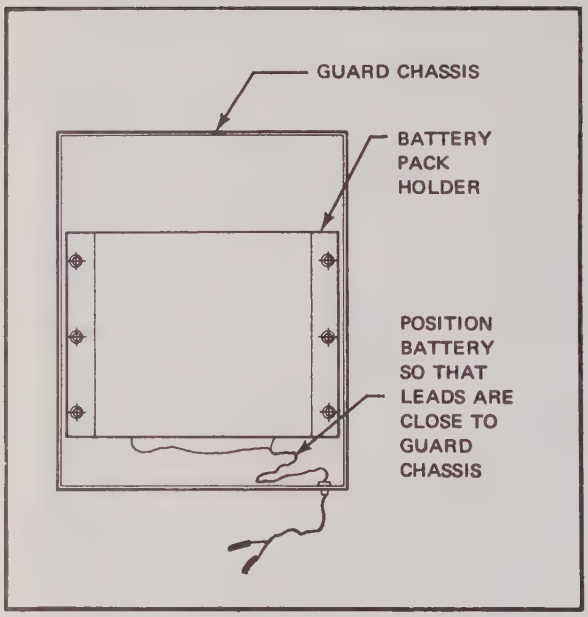


Figure 6-9. BATTERY INSTALLATION

h. Replace the top guard chassis and connect the battery leads to the battery connector pins at the right-rear of the PCB as shown Figure 6-7.

i. Replace the bottom guard chassis and top and bottom dust covers.

6-18. Operating Instructions

6-19. The battery supplies power to the instrument whenever the instrument is disconnected from the line. The front panel meter monitors the charge condition of the batteries during battery operation. During line operation, while the batteries are charging, the meter indicates LINE OPR (full-scale). When fully charged, the batteries will provide 8 hours of continuous operation before recharging is necessary. When fully discharged, the batteries will require a maximum of 10 hours to fully charge.

6-20. The ballast lamp provides constant current charge even though line and battery levels may vary.

6-21. LIST OF REPLACEABLE PARTS

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		DIGITAL MULTIMETER – BATTERY OPTION*	8100A-01					
BT1		Battery Pack	269837	89536	269837	1		
M1		Meter, 0-1 ma (See Figure 5-1)	266494	89536	266494	1		
XBT1		Holder, battery pack	269712	89536	269712	1		
		Add the following components to the Printed Circuit Assembly (A1):						
CR32	E5-Z3	Diode, silicon, 1 amp, 600 piv (See Figure 5-3)	112383	05277	1N4822	2		
CR33	E5-Z2	Diode, silicon, 1 amp, 600 piv (See Figure 5-3)	112383	05277	1N4822	REF		
CR34	F5-Z2	Diode, silicon, 1 amp, 100 piv (See Figure 5-3)	116111	05277	1N4817	1		
DS11	G3-AA3	Lamp, incandescent, 24v (See Figure 5-3)	218354	08806	1252	1	2	
R182	F5-Z3	Res, comp, 2Ω ±5%, ½w (See Figure 5-3)	218735	01121	EB20G5	1		
R183	I3-AA3	Res, met flm, 11.5k ±1%, 1/8w (See Figure 5-3)	267138	91637	Type MFF 1/8	1		

* Option Kit, part number 269886, includes the following components. Instructions for kit installation are given in preceeding text.

ACCESSORY INFORMATION

MODEL A90 CURRENT SHUNT

6-1. INTRODUCTION

6-2. The Model A90 Current Shunt is designed for use with any high-impedance ac or dc voltmeter capable of accurately measuring 100 millivolts. Six Fluke precision wire wound and strip resistors provide a 100 millivolt full-scale output for each of six pushbutton current ranges: 0.1, 1, 10, 100, and 1000 milliamperes and 10 amperes (ac or dc). Basic accuracy is specified over a frequency range of dc to 4 kHz for the 10 ampere range and dc to 10 kHz for the milliampere ranges.

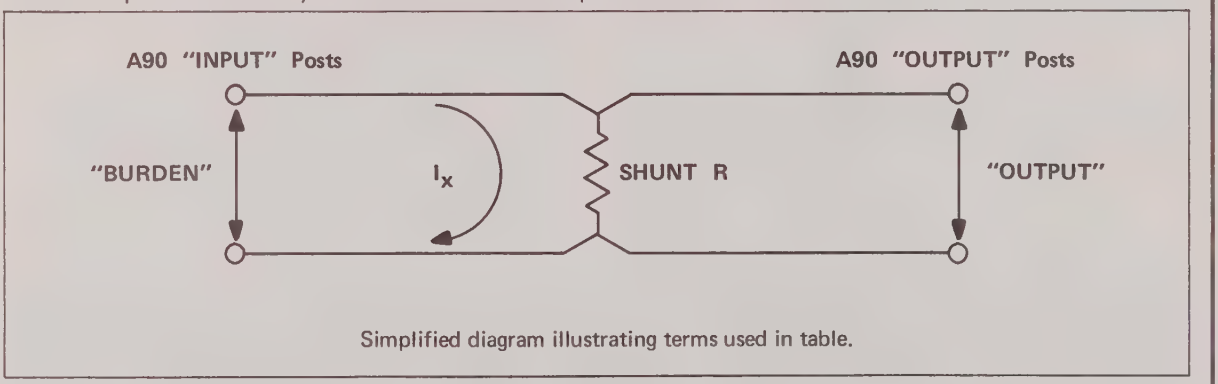
6-3. The instrument is supplied in half-rack case so that it may be conveniently mounted side-by-side with other half-rack instruments in a standard 19-inch rack. A carrying handle detents into custom non-marring feet and serves as a tilt-up bail for bench use.

Figure 6-1. MODEL A90 CURRENT SHUNT

Table 6-1. ACCURACY OF A90 (1 year, 15°C - 35°C)

RATED CURRENT RANGE	E BURDEN (APPROX.)	SHUNT R	"OUTPUT" AT RATED CURRENT	"OUTPUT" ACCURACY AS % OF CURRENT INPUT	
				DC ONLY	DC TO 10 KHZ AC
0.1 ma	100 mv	1 kΩ	100 mv	±0.1%	±0.1%
* 0.1 ma	100 mv	1 kΩ	100 mv	+0.0% –0.2%	+0.0% –0.2%
1.0 ma	100 mv	100Ω	100 mv	±0.1%	±0.1%
10 ma	100 mv	10Ω	100 mv	±0.1%	±0.1%
100 ma	102 mv	1Ω	100 mv	±0.1%	±0.1%
1A	120 mv	0.1Ω	100 mv	±0.1%	±0.2%
10A	300 mv	0.01Ω	100 mv	±0.2%	±0.3% (to 4 kHz)

* With 1 MΩ Input R Voltmeter.
When Input R is ⩾10 MΩ, use non-asterisked 0.1 ma specification.



Simplified diagram illustrating terms used in table.

6-4. SPECIFICATIONS

6-5. Electrical

RANGE
0.1, 1, 10, 100, and 1000 milliamps and 10 amperes.

ACCURACY
Table 6-1 gives accuracy specifications for the Model A90 only. Total current measurement accuracy is also dependent on the accuracy and input impedance of the voltmeter being used.

SENSITIVITY
100 millivolts full scale.

OVERLOAD
Model A90 will not be damaged by 100% overload on each range below 10 amperes or by 50% overload on the 10 ampere range.

6-6. Mechanical

CURRENT SELECTION
Pushbutton, each range.

CONNECTORS
Positive (+) and negative (–) INPUT and OUTPUT binding posts with separate input posts for 10 ampere range.

DIMENSIONS
The Model A90 outline drawing is shown in Figure 6-2.

RACK MOUNTING KITS (OPTIONAL)
MEE-7014: Side-by-side Half-rack Mounting Kit
MEE-7006: Center Rack Mounting Kit
MEE-7013: Left or right of center Mounting Kit.

6-7. AUXILIARY ELECTRICAL SPECIFICATIONS

6-8. Tables 6-2 through 6-6 provide accuracy specifications for the Model A90 when used with Fluke Models

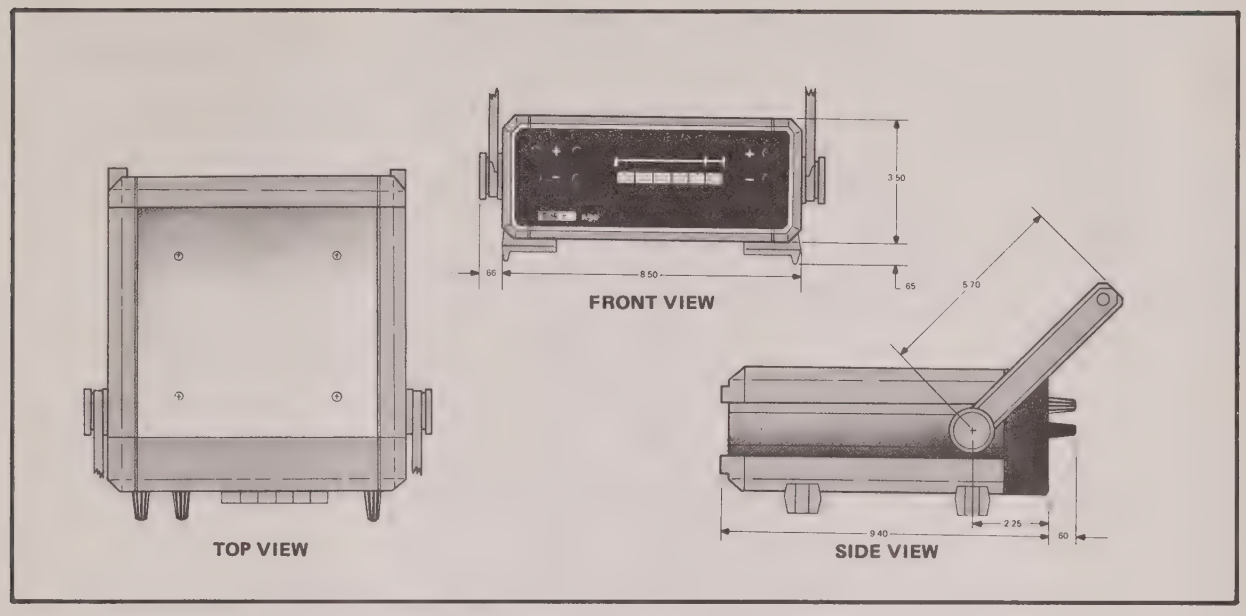


Figure 6-2. MODEL A90 OUTLINE DRAWING

Table 6-2. A90/8100A ACCURACY. 30 days, @ 23°C ±5°C.

DC ACCURACY	
CURRENT RANGE	SPECIFICATION
0.1 ma	±(0.12% of current input + 0.1 ua)
1.0 ma	±(0.12% of current input + 1.0 ua)
10 ma	±(0.12% of current input + 10 ua)
100 ma	±(0.12% of current input + 0.1 ma)
1A	±(0.12% of current input + 1.0 ma)
10A	±(0.22% of current input + 10 ma)

AC ACCURACY		
CURRENT RANGE	30 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.5% of current input + 1.0 ua) –(0.7% of current input + 1.0 ua)	+(0.2% of current input + 0.5 ua) –(0.4% of current input + 0.5 ua)
1.0 ma	±(0.6% of current input + 10 ua)	±(0.3% of current input + 5.0 ua)
10 ma	±(0.6% of current input + 0.1 ma)	±(0.3% of current input + 50 ua)
100 ma	±(0.6% of current input + 1.0 ma)	±(0.3% of current input + 0.5 ma)
1A	±(0.7% of current input + 10 ma)	±(0.4% of current input + 5.0 ma)
10A	±(0.8% of current input + 100 ma)	±(0.5% of current input + 50 ma)*

*10A specified to 4 kHz only.

For:	DC CURRENT	AC CURRENT
	V_r = 1v	V_r = 1v
	V_{dfs} = ±.1000	V_{dfs} = .1000

Table 6-3. A90/8300A ACCURACY

DC CURRENT ACCURACY

MEASUREMENTS WITHOUT MV/OHMS OPTION INSTALLED

CURRENT RANGE	24 hr @ 23°C ±1°C	90 days @ 23°C ±5°C
0.1 ma	±(0.1% of current input + 0.1 ua)	±(0.11% of current input + 0.3 ua)
1.0 ma	±(0.1% of current input + 1.0 ua)	±(0.11% of current input + 3.0 ua)
10 ma	±(0.1% of current input + 10 ua)	±(0.11% of current input + 30 ua)
100 ma	±(0.1% of current input + 0.1 ma)	±(0.11% of current input + 0.3 ma)
1A	±(0.1% of current input + 1.0 ma)	±(0.11% of current input + 3.0 ma)
10A	±(0.2% of current input + 10 ma)	±(0.21% of current input + 30 ma)

V_r = 10 VDC

V_{dfs} = 0.1000 (Readout also will display "DC +" or "DC –").

MEASUREMENTS WITH MV/OHMS OPTION (8300A-02) INSTALLED

CURRENT RANGE	90 days @ 23°C ±5°C
0.1 ma	±(0.11% of current input + 0.01 ua)
1.0 ma	±(0.11% of current input + 0.1 ua)
10 ma	±(0.11% of current input + 1.0 ua)
100 ma	±(0.11% of current input + 10 ua)
1A	±(0.11% of current input + 0.1 ma)
10A	±(0.21% of current input + 1.0 ma)

V_r = 100 MV (0.1v)

V_{dfs} = 100.000 (Readout will also display MV DC + or MV DC–)

AC CURRENT ACCURACY

MEASUREMENTS WITH AC OPTION 8300A-01 INSTALLED

90 days @ 23°C ±5°C using AC Zero control periodically.

CURRENT RANGE	30 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.5% of current input + 0.05 ua) –(0.7% of current input + 0.05 ua)	+(0.1% of current input + 0.05 ua) –(0.3% of current input + 0.05 ua)
1.0 ma	±(0.6% of current input + 0.5 ua)	±(0.2% of current input + 0.5 ua)
10 ma	±(0.6% of current input + 5.0 ua)	±(0.2% of current input + 5.0 ua)
100 ma	±(0.6% of current input + 50 ua)	±(0.2% of current input + 50 ua)
1A	±(0.7% of current input + 0.5 ma)	±(0.3% of current input + 0.5 ma)
10A	±(0.8% of current input + 5.0 ma)	±(0.4% of current input + 5.0 ma)*

V_r = 1 VAC

V_{dfs} = .10000 (Readout will also display "AC")

*10A specified to 4 kHz only.

Table 6-4. A90/9500A SPECIFICATIONS

ACCURACY WHEN UNKNOWN CURRENT IS 20% OR MORE OF A90 CURRENT RANGE. (23°C ±1°C)

CURRENT RANGE	20 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.3% of current input + 0.02 ua) –(0.5% of current input + 0.02 ua)	+(0.05% of current input + 0.015 ua) –(0.25% of current input + 0.015 ua)
1.0 ma	±(0.4% of current input + 0.2 ua)	±(0.15% of current input + 0.15 ua)
10 ma	±(0.4% of current input + 2.0 ua)	±(0.15% of current input + 1.5 ua)
100 ma	±(0.4% of current input + 20 ua)	±(0.15% of current input + 15 ua)
1A	±(0.5% of current input + 0.2 ma)	±(0.25% of current input + 0.15 ma)
10A	±(0.6% of current input + 2.0 ma)	±(0.35% of current input + 1.5 ma)*

ACCURACY WHEN UNKNOWN CURRENT IS BETWEEN 10% AND 20% OF A90 CURRENT RANGE.

A90 INPUT (% OF CURRENT RANGE)	% OF INPUT ABSOLUTE ACCURACY 20 Hz – 50 Hz @ 23°C ±1°C FOR A90 CURRENT RANGE				
	0.1 ma				
	+	–	1 ma – 100 ma	1A	10A
10-11%	0.53%	0.73%	± 0.63%	±0.73%	±0.83%
12-14%	0.50%	0.70%	± 0.60%	±0.70%	±0.80%
15-17%	0.47%	0.67%	± 0.57%	±0.67%	±0.77%
18-20%	0.44%	0.64%	± 0.54%	±0.64%	±0.74%

A90 INPUT (% OF CURRENT RANGE)	% OF INPUT ABSOLUTE ACCURACY 50 Hz – 10 kHz @23°C ±1°C FOR A90 CURRENT RANGE				
	0.1 ma				
	+	–	1 ma – 100 ma	1A	10A*
10-11%	0.23%	0.43%	±0.33%	±0.43%	±0.53%
12-14%	0.20%	0.40%	±0.30%	±0.40%	±0.50%
15-17%	0.17%	0.37%	±0.27%	±0.37%	±0.47%
18-20%	0.13%	0.33%	±0.23%	±0.33%	±0.43%

V_r = .1v

V_{dfs} = .10000

TC = 0.005% of current input/°C 20 Hz –50 Hz
0.004% of current input/°C 50 Hz – 10 kHz

*10A is specified to 4 kHz only.

8100A, 8300A, 9500A, 891A, 893A, and 931B. Table 6-7 gives V_r and V_{dfs} for each of the voltmeters listed in the tables in addition to various other Fluke voltmeters, where

V_r = Voltage range to be used on the voltmeter
and V_{dfs} = Nominal voltmeter reading with full-scale current in A90 shunt.

6-9. INSTALLATION

6-10. There are three rack-mount kits available, at additional cost, for use with the Model A90. Kit MEE-7014 allows the Model A90 to be mounted side-by-side with another half-rack instrument in a standard 19-inch rack. Kit MEE-7006 supplies hardware necessary to mount the

Table 6-5. A90/891A AND 893A ACCURACY (Sheet 1 of 2)

WITH 891A AND 893A – DC ACCURACY		
CURRENT RANGE	@ 23°C ±2°C	@ 15°C –35°C
0.1 ma	±(0.11% of current input + 0.02 ua)	±(0.12% of current input + 0.02 ua)
1.0 ma	±(0.11% of current input + 0.2 ua)	±(0.12% of current input + 0.2 ua)
10 ma	±(0.11% of current input + 2.0 ua)	±(0.12% of current input + 2.0 ua)
100 ma	±(0.11% of current input + 20 ua)	±(0.12% of current input + 20 ua)
1A	±(0.11% of current input + 0.2 ma)	±(0.12% of current input + 0.2 ma)
10A	±(0.21% of current input + 2.0 ma)	±(0.22% of current input + 2.0 ma)
V_r = 1v V_{dfs} = 0.10000		

WITH 893A – AC ACCURACY @ 23°C ±2°C	
CURRENT RANGE	50 Hz – 10 kHz
0.1 ma	+(0.05% of current input + 0.025 ua) –(0.25% of current input + 0.025 ua)
1.0 ma	±(0.15% of current input + 0.25 ua)
10 ma	±(0.15% of current input + 2.5 ua)
100 ma	±(0.15% of current input + 25 ua)
1A	±(0.25% of current input + 0.25 ma)
10A	±(0.35% of current input + 2.5 ma)*

WITH 893A – AC ACCURACY @ 15°C –35°C		
CURRENT RANGE	5 Hz – 10 Hz	10 Hz – 20 Hz
0.1 ma	+(1.0% of current input + 0.25 ua) –(1.2% of current input + 0.25 ua)	+(0.5% of current input + 0.1 ua) –(0.7% of current input + 0.1 ua)
1.0 ma	±(1.1% of current input + 2.5 ua)	±(0.6% of current input + 1.0 ua)
10 ma	±(1.1% of current input + 25 ua)	±(0.6% of current input + 10 ua)
100 ma	±(1.1% of current input + 0.25 ua)	+(0.6% of current input + 0.1 ma)
1A	±(1.2% of current input + 2.5 ma)	±(0.7% of current input + 1.0 ma)
10A	±(1.3% of current input + 25 ma)	±(0.8% of current input + 10 ma)

893A – AC ACCURACY @ 15°C –35°C.		
CURRENT RANGE	20 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.15% of current input + 0.025 ua) –(0.35% of current input + 0.025 ua)	+(0.1% of current input + 0.025 ua) –(0.3% of current input + 0.025 ua)
1.0 ma	±(0.25% of current input + 0.25 ua)	±(0.2% of current input + 0.25 ua)
10 ma	±(0.25% of current input + 2.5 ua)	±(0.2% of current input + 2.5 ua)
100 ma	±(0.25% of current input + 25 ua)	±(0.2% of current input + 25 ua)
1A	±(0.35% of current input + 0.25 ma)	±(0.3% of current input + 0.25 ma)
10A	±(0.45% of current input + 2.5 ma)	±(0.4% of current input + 2.5 ma)*

Table 6-5. A90/891A AND 893A ACCURACY (Sheet 2 of 2)

V_r = 1v (AC or DC) V_{dfs} = 0.10000 *10A is specified to 4 kHz only.

Table 6-6. A90/931B SPECIFICATIONS

ACCURACY WHEN UNKNOWN CURRENT IS 10% OR MORE OF A90 CURRENT RANGE				
CURRENT RANGE	% OF INPUT ABSOLUTE ACCURACY 2 Hz – 3 Hz	3 Hz – 5 Hz	5 Hz – 30 Hz	SPECIFICATIONS 30 Hz – 10 kHz
0.1 ma	+1.0% –1.2%	+0.5% –0.7%	+0.2% –0.4%	+(0.05% of current input + 5 na) –(0.25% of current input + 5 na)
1.0 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 50 na)
10 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 0.5 ua)
100 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 5 ua)
1A	±1.2%	±0.7%	±0.4%	±(0.25% of current input + 50 ua)
10A	±1.3%	±0.8%	±0.5%	±(0.35% of current input + 0.5 ma)*
TC=	±0.1%/°C	±0.05%/°C	±0.025%/°C	±0.0025%/°C

V_r = 100 MV
V_{dfs} = 100.000

*10A is specified to 4 kHz only.

Table 6-7. "V_r" AND "V_{dfs}" FOR VOLTMETERS OF TABLES 6-2 THROUGH 6-6

VOLTMETER	"V_r"	"V_{dfs}"
8300A (Without MV/Ohms)	10v	.010
8100A, 871A, 873A, 881A, 883A, 885A, 887A, 891A, 893A	1v	.100
801, 803, 801B, 803B, 803D, 821A, 823A, 825A	0.5v	.100
9500A, 910A	0.1v	.100
8300A (With MV/Ohms), 931A, 931B	100 MV	100.0

V_r = Voltage range to be used on the voltmeter.
V_{dfs} = Nominal voltmeter reading with full-scale current in A90 shunt.

instrument in the center of the rack. Kit MEE-7013 supplies two different sized rack ears so that the instrument can be mounted to the left or to the right of rack center.

6-11. OPERATING INSTRUCTIONS

6-12. A description of Model A90 controls and terminals is given in Figure 6-3.

6-13. Equipment Connections

6-14. It is recommended that the Model A90 always be used in the "LO" lead as shown in Figure 6-4A. When used in the "HI" lead, as shown in Figure 6-4B, the distributed capacitance, C_{DIST}, loads the source. When connected in the "HI" lead, the voltmeter guard should either be connected as shown or else the voltmeter should be battery operated.

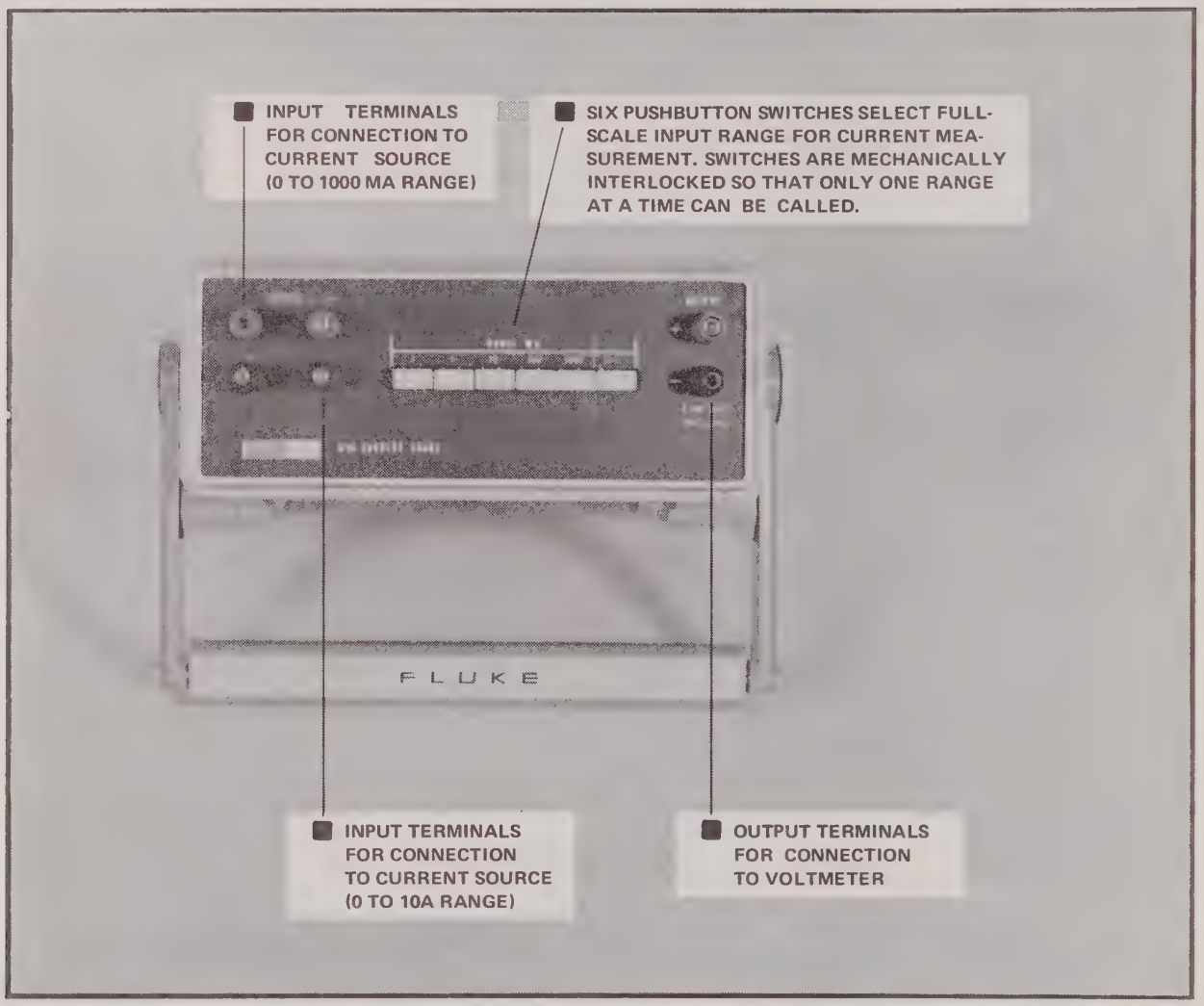

INPUT TERMINALS FOR CONNECTION TO CURRENT SOURCE (0 TO 1000 MA RANGE)
SIX PUSHBUTTON SWITCHES SELECT FULL-SCALE INPUT RANGE FOR CURRENT MEASUREMENT. SWITCHES ARE MECHANICALLY INTERLOCKED SO THAT ONLY ONE RANGE AT A TIME CAN BE CALLED.
FLUKE
INPUT TERMINALS FOR CONNECTION TO CURRENT SOURCE (0 TO 10A RANGE)
OUTPUT TERMINALS FOR CONNECTION TO VOLTMETER

Figure 6-3. MODEL A90 CONTROLS AND TERMINALS.

6-15. At high ac currents, performance of the A90 may depend upon the manner in which the current leads are connected to the input binding posts. Optimum performance is obtained when the input current leads are twisted.

6-16. Voltmeter Impedance

6-17. The input impedance of the voltmeter which is used with the Model A90 is significant with regard to total measurement accuracy. As indicated in the specifications, Model A90 measurement accuracy is derated for voltmeters having finite input impedance. As the voltmeter input capacity increases, the Model A90 response rolls off at the high end; and as the voltmeter input resistance decreases, the response shifts downward, resulting in negative measurement errors.

6-18. Combining Model A90 And Voltmeter Specifications

6-19. Combined specifications for the A90 when used with various Fluke voltmeters is given in Tables 6-2 through 6-6. When the A90 is used with other voltmeters, the following information may be used to combine specifications.

6-20. Equation 1 (Figure 6-5) is used to combine A90 and voltmeter specifications for overall accuracy. The "W" term is taken from Table 6-1, and the "X", "Y" and "Z" terms are taken from voltmeter specifications (data sheets). All Fluke voltmeter specifications, except the Model 910A, contain the "X" term; they usually list the "Y" term and occasionally the "Z" term. Model 910A accuracy specifi-

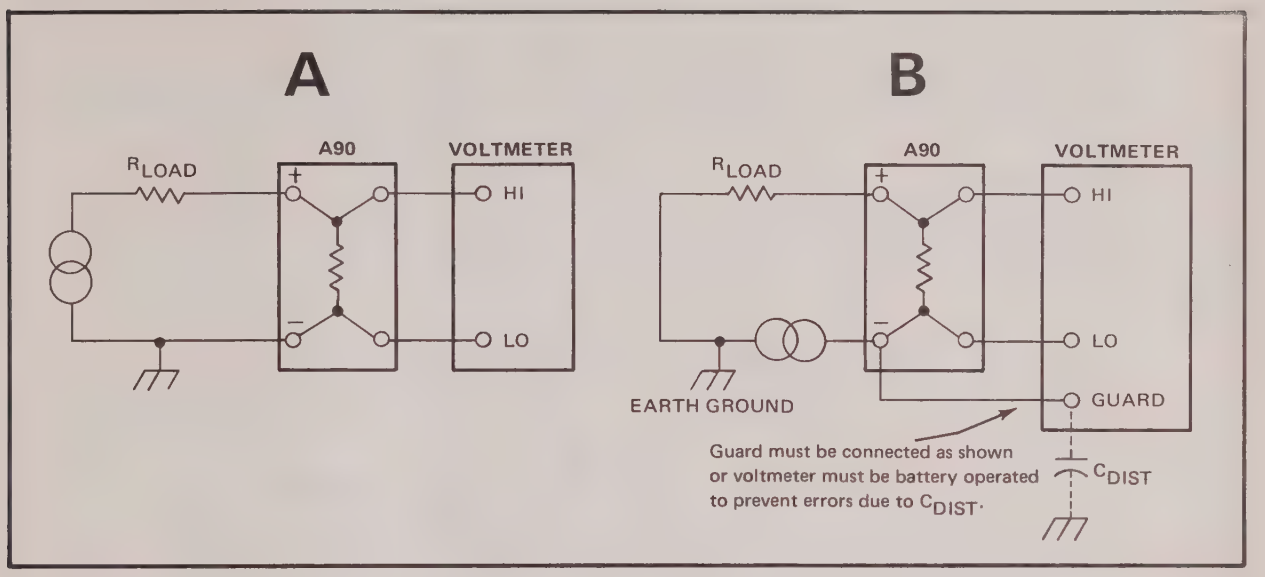


Figure 6-4. EQUIPMENT CONNECTIONS FOR CURRENT MEASUREMENT.

EQUATION 1. COMBINING A-90 SPECIFICATION WITH VOLTMETER SPECIFICATION.

A-90 Specification (from Table 6-1)

Voltmeter Specification (from Voltmeter Data Sheet)

$$\pm \left| W \right| \% \qquad \pm \left(\left| X \right| \% \text{ of input} + \left| Y \right| \% \text{ of range} + \left| Z \right| \text{ uv} \right)$$

Vr = Lowest voltmeter range that will measure 100 MV

$$= + \left[\left(W + X \right) \% \text{ of current input} + \frac{Vr}{0.1} \times \left(Y + \frac{Z}{10000} \right) \% \text{ of current range} \right]$$

EXAMPLE 1: Accuracy using 10 ma DC A-90 range with 891A.

A-90 Specification (from Table 6-1)

891A Specification (from 891A Data Sheet)

$$\pm \left| 0.1 \right| \% \qquad \pm \left(\left| 0.01 \right| \% \text{ of input} + \left| 0.001 \right| \% \text{ of range} + \left| 10 \right| \text{ uv} \right)$$

Vr = 1.0 (891A's 1v DC Range)

$$= \pm \left[(0.1 + 0.01) \% \text{ of current input} + \frac{1.0}{0.1} \times \left(0.001 + \frac{10}{10{,}000} \right) \% \text{ of current range} \right]$$

$$= \pm \left[0.11\% \text{ of current input} + 0.02\% \text{ of current range} \right]$$

$$= \pm \left[0.11\% \text{ of current input} + 2 \text{ ua} \right]$$

Figure 6-5. EQUATION 1 – COMBINING A90 AND VOLTMETER SPECIFICATIONS (Sheet 1 of 2)

EXAMPLE 2: Accuracy using 0.1 ma AC A-90 range with 873A at 1 kHz.

Model 873A has 1 megohm input impedance in its AC mode so separate accuracy statements are required for positive and negative limits of error for measurements made on the A-90's 0.1 ma range.

Positive Limit of Error

A-90 Specification | 873A Specification

+ | 0.0 | % ± | 0.2 | % of input + | 25 | uv

"Vr" is 873A's 1v AC Range — No "Y" Term In Spec.

$$= +\left[(0.0 + 0.2)\ \%\ \text{of current input} + \frac{1}{0.1} \times \left(0 + \frac{25}{10000}\right)\ \%\ \text{of current range}\right]$$

$$= +\left[\ 0.2\%\ \text{of current input} + 0.025\%\ \text{of current range}\ \right]$$

Negative Limit of Error

$$= -\left[\ (0.2 + 0.2)\ \%\ \text{of current input} + 0.025\%\ \text{of current range}\ \right]$$

$$= -\left[\ 0.4\%\ \text{of current input} + 0.025\%\ \text{of current range.}\ \right]$$

Figure 6-5. EQUATION 1 – COMBINING A90 AND VOLTMETER SPECIFICATIONS (Sheet 2 of 2)

cation consists of "Y" term only. If "X", "Y", or "Z" do not appear in a voltmeter accuracy specification, it should be treated as a zero in Equation 1. The voltmeter must be used on the lowest range that can measure 100 millivolts. This range is assigned the symbol "V_r" in Equation 1. V_r is always stated as volts, i.e., 100 millivolt range equals 0.1 volts for V_r .

6-21. Equation 2 (Figure 6-6) may be used to convert the voltmeter voltage reading to current.

6-22. THEORY OF OPERATION

6-23. The schematic diagram of the Model A90 is located at the back of the manual. In the milliampere ranges, current is directed through the appropriate shunt resistor by switches S1A through S5A, and the corresponding output voltage is connected to the output terminals through switches S1 through S5, decks B and C. In 10 ampere range, the input current is applied directly to the shunt resistor, and the output voltage is connected to the output terminals through switch S6.

6-24. All shunt resistors are four-terminal shunts or are connected in a four-terminal switching arrangement so that lead resistance does not affect measurement accuracy.

6-25. MAINTENANCE

6-26. The following paragraphs contain instructions for cleaning and calibrating the Model A90.

6-27. Cleaning

6-28. The instrument should be cleaned periodically to remove dust, grease, and other contamination. The following procedure should be adhered to when cleaning the instrument:

a. Remove loose contamination with low-pressure, clean, dry air.

b. Clean front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened in a mild solution of detergent and water.

CAUTION!

Do not use aromatic hydrocarbons or chlorinated solvents on the front panel, because they will react with the Lexan binding posts.

$$I_x = I_r \times \frac{V_d}{V_{dfs}}$$

Where:
- I_x = magnitude of unknown current in units of A90 "RANGE" used. (i.e. ma or amps).
- I_r = A90 Rated Current "RANGE".
- V_d = Voltmeter reading.
- V_{dfs} = Nominal Voltmeter reading with rated current flowing in A90. "V_{dfs}" and "V_r" are tabulated in Table 6-7 for each voltmeter listed in Tables 6-2 through 6-6. Note that "V_{dfs}" multiplies or divides "V_d" by powers of 10 so it is simple to manipulate.

EQUATION 2. CONVERTING VOLTAGE READINGS TO CURRENT

Example: An 8100A reads =.0643 when used with an A90 in the 10 ma range. What current is flowing?

- I_r = 10 ma (A90 "Rated Current Range")
- V_d = .0643 (Voltmeter reading)
- V_{dfs} = .1000 (From Table 6-7)

Answer: $I_x = 10 \text{ ma} \times \frac{.0643}{.1000} = 6.43 \text{ ma}$

Figure 6-6. Equation 2 — CONVERTING VOLTAGE READINGS TO CURRENT

6-29. Test Equipment

6-30. Test equipment required for calibration and testing of the Model A90 is shown in Table 6-8. If the recommended equipment is not available, other equivalent equipment may be used.

Table 6-8. LIST OF TEST EQUIPMENT

NAME	RECOMMENDED EQUIPMENT
Constant Current Source	Fluke Model 382A
DC Differential Voltmeter	Fluke Model 895A or 885A
Low-Thermal Leads	
4-Terminal Ohmmeter	Fluke Model 8300A with Option -02

6-31. Calibration

6-32. PRELIMINARY CHECKS. Make the resistance checks shown in Table 6-9. Values are approximate since check is intended to show only gross errors, such as defective or open resistors.

6-33. .1 MA AND 1 MA RANGE CHECKS. Connect the ohmmeter and A90, as shown in Figure 6-7, for 4-terminal resistance measurements, and perform the following steps:

a. Set the A90 to the .1 MA range. The ohmmeter should indicate between 1.00050 and 0.99950 kilohms. If the measured resistance is not within these limits, the .1 MA shunt, R6, is defective and must be replaced.

b. Set the A90 to the 1 MA range. The ohmmeter should indicate between 100.07 and 99.93 ohms. If the measured resistance is not within these limits, the 1 MA shunt, R5, is defective and must be replaced.

6-34. 10 MA, 100 MA, AND 1000 MA RANGE CHECKS. Connect the constant current generator, differential voltmeter, and A90 as shown in Figure 6-8 and perform the following steps:

a. Set the A90 to the 10 MA range.

b. Set the differential voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	0.100000

Table 6-9. RESISTANCE CHECKS

OHMMETER CONNECTIONS	MODEL A90	
	RANGE	APPROXIMATE RESISTANCE (OHMS)
INPUT Terminals	.1 MA	1000
	1 MA	100
	10 MA	10
	100 MA	1
	1000 MA	0.1
	10A	∞
INPUT (10A Terminals)	10A	0.01
OUTPUT Terminals	10A	0.01
	1000 MA	0.1
	100 MA	1
	10 MA	10
	1 MA	100
	.1 MA	1000

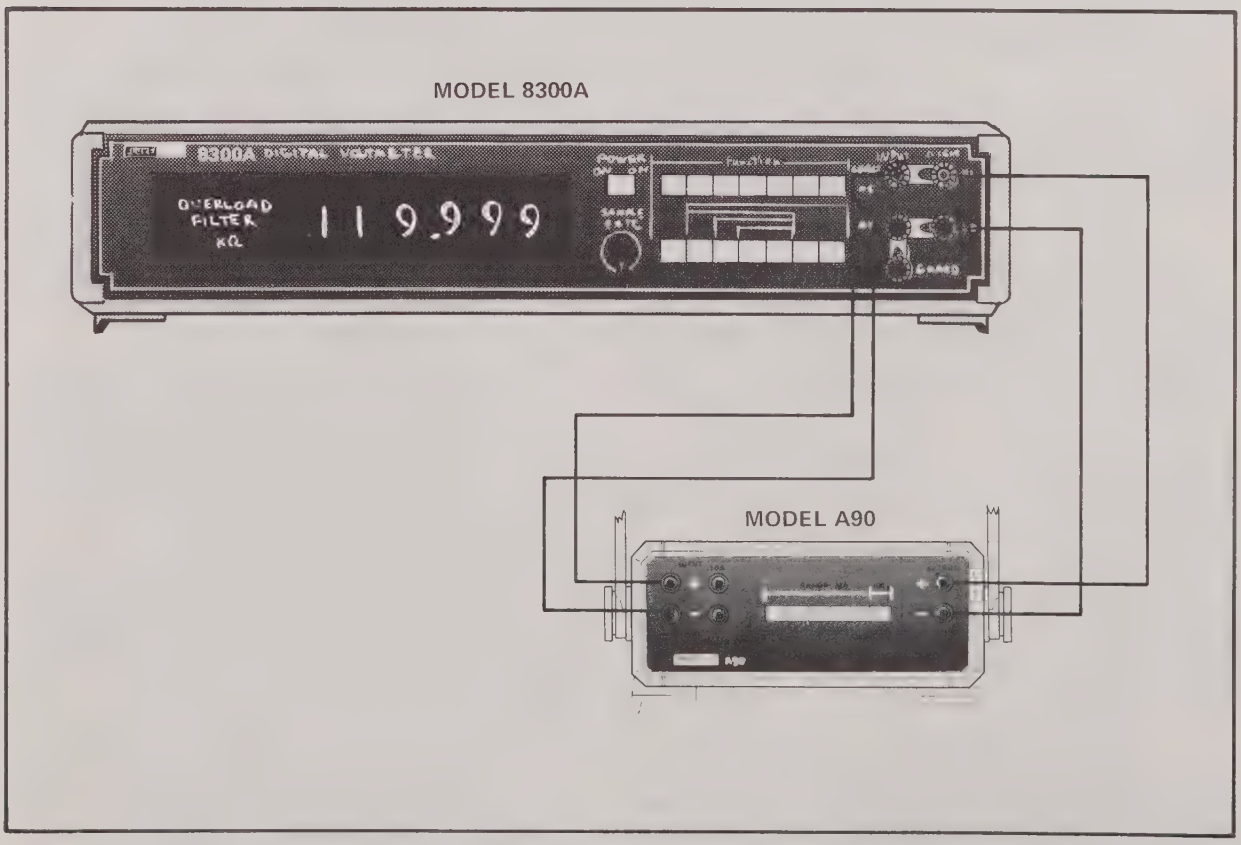


Figure 6-7. EQUIPMENT CONNECTIONS – .1 MA AND 1 MA RANGE CHECKS

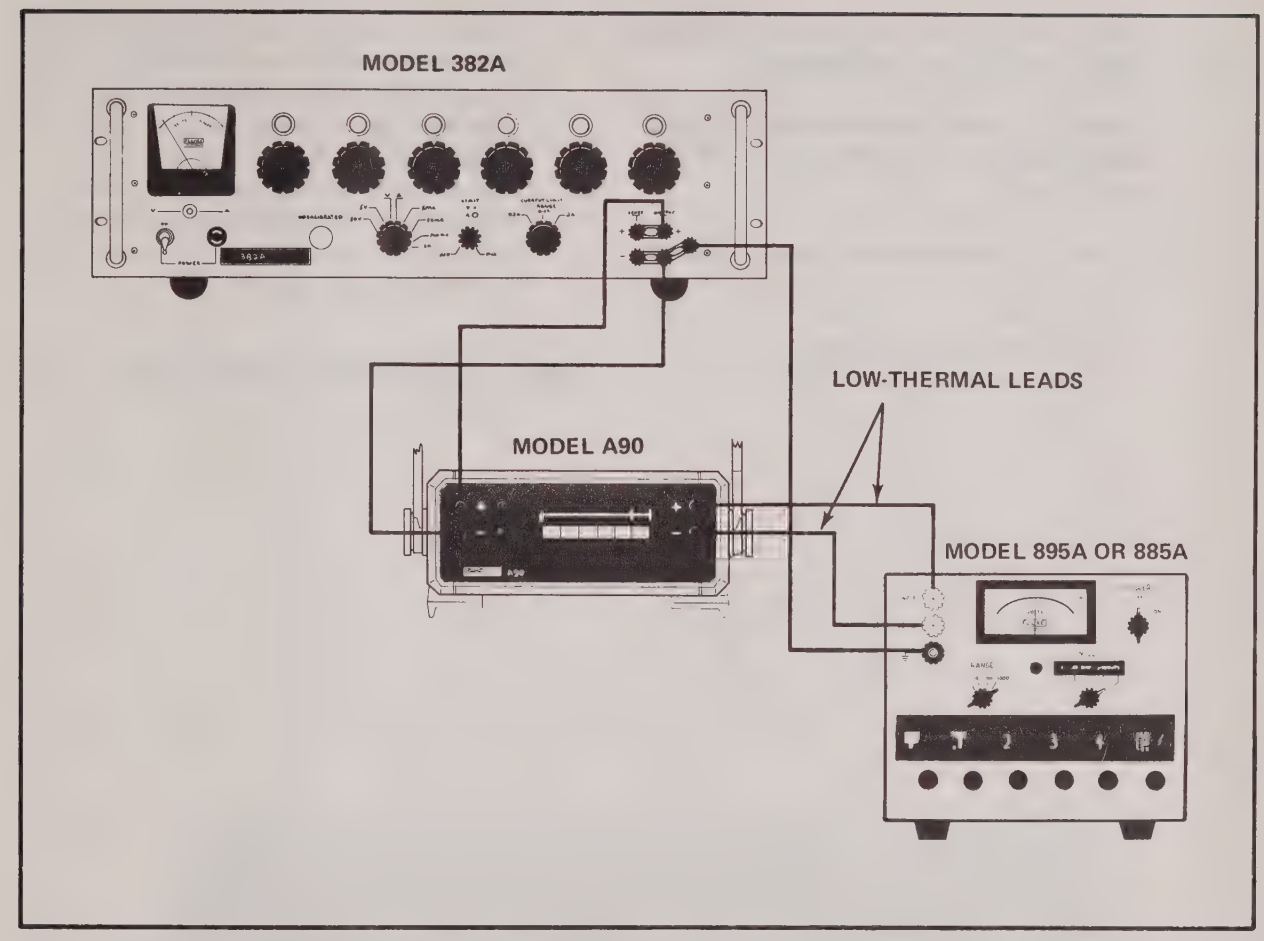


Figure 6-8. EQUIPMENT CONNECTIONS – 10 MA, 100 MA, AND 1000 MA RANGE CHECKS

c. Set the constant current generator for 10.0000 milliamperes output. The differential voltmeter should indicate null within ±80 micorvolts. If the voltmeter does not indicate within these limits, the 10 MA shunt, R4, is defective and must be replaced.

d. Change the A90 range to 100 MA and the constant current generator output to 100 milliamperes. The differential voltmeter should indicate null within ±80 microvolts. If the voltmeter does not indicate within these limits, the 100 MA shunt, R3, is defective and must be replaced.

e. Change the A90 range to 1000 MA and the constant current generator output to 1000 milliamperes. The differential voltmeter should indicate null within ±80 microvolts. If the +80 microvolt limit is not met, the 1000 MA shunt, R2, should be replaced. If the –80 microvolt limit is not met, R2 is low in ohmic value and can be trimmed to its desired value by carefully removing a small amount of material from the edge of the shunt using a whetstone.

6-35. 10 AMPERE RANGE CHECK. Connect equipment as shown in Figure 6-8, leaving the constant current generator temporarily disconnected from the A90, and perform the following steps:

a. Set the differnetial voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	0.00000

The voltmeter should indicate less than ±4 microvolts of thermal offset. If more than ±4 microvolts of offset is observed, check for cold solder joints or possible thermal generators in the test

setup. When thermal offset has been reduced to within ±4 microvolts, proceed to step (b).

b. Connect the constant current generator to the 10 AMP binding posts of the A90 and set the A90 to the 10A range.

c. Set the differential voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	.020000

d. Set the constant current generator output to 2 amperes. The voltmeter should indicate null within ±80 microvolts. If the +80 microvolt limit is not met, the 10 ampere shunt, R1, should be replaced. If the −80 microvolt limit is not met, R1 is low in ohmic value and can be trimmed to its desired value by carefully removing a small amount of material from the edge of the shunt using a whetstone.

6-36. LIST OF REPLACEABLE PARTS

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		CURRENT SHUNT — Figure 6-9	A90					
		Shunt PCB Assembly (See Figure 6-9)	A90-403	89536	A90-403	1		
J1, J2, J5		Binding post, red, +	275552	89536	275552	3		
J3, J4, J6		Binding post, black –	275560	89536	275560	3		
		Cover, bottom	224360	89536	224360	1		
		Cover, top	224352	89536	224352	1		
		Foot	230037	89536	230337	4		
		Handle, carrying	231423	89536	231423	1		
		Panel, front	A90-208	89536	A90-208	1		
		Panel, rear	A90-209	89536	A90-209	1		

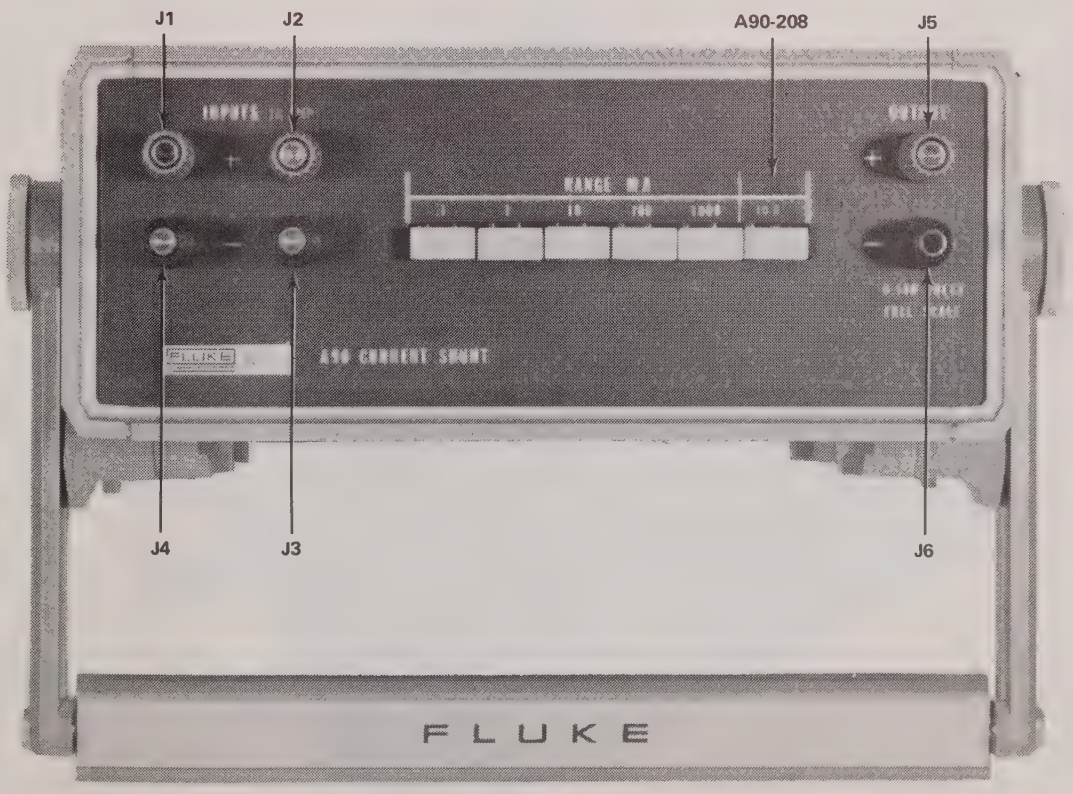


Figure 6-9. MODEL A90 CURRENT SHUNT (Sheet 1 of 2)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		SHUNT PCB ASSEMBLY — Figure 6-9	A90-403	89536	A90-403	REF		
R1		Res, ww, 0.010Ω ±0.2%, 1w	34-4022	89536	34-4022	1		
R2		Res, ww, 0.10Ω ±0.1%, 1w	224121	89536	224121	1		
R3		Res, ww, 1.0Ω ±0.1%, ½w	224089	89536	224089	1		
R4		Res, ww, 10Ω ±0.1%, ½w	224071	89536	224071	1		
R5		Res, ww, 100Ω ±0.03%, ½w	155846	89536	155846	1		
R6		Res, ww, 1 KΩ ±0.04%, ½w	131706	89536	131706	1		
S1 thru S6		Switch assembly,RANGE MA	A90-802	89536	A90-802	1		

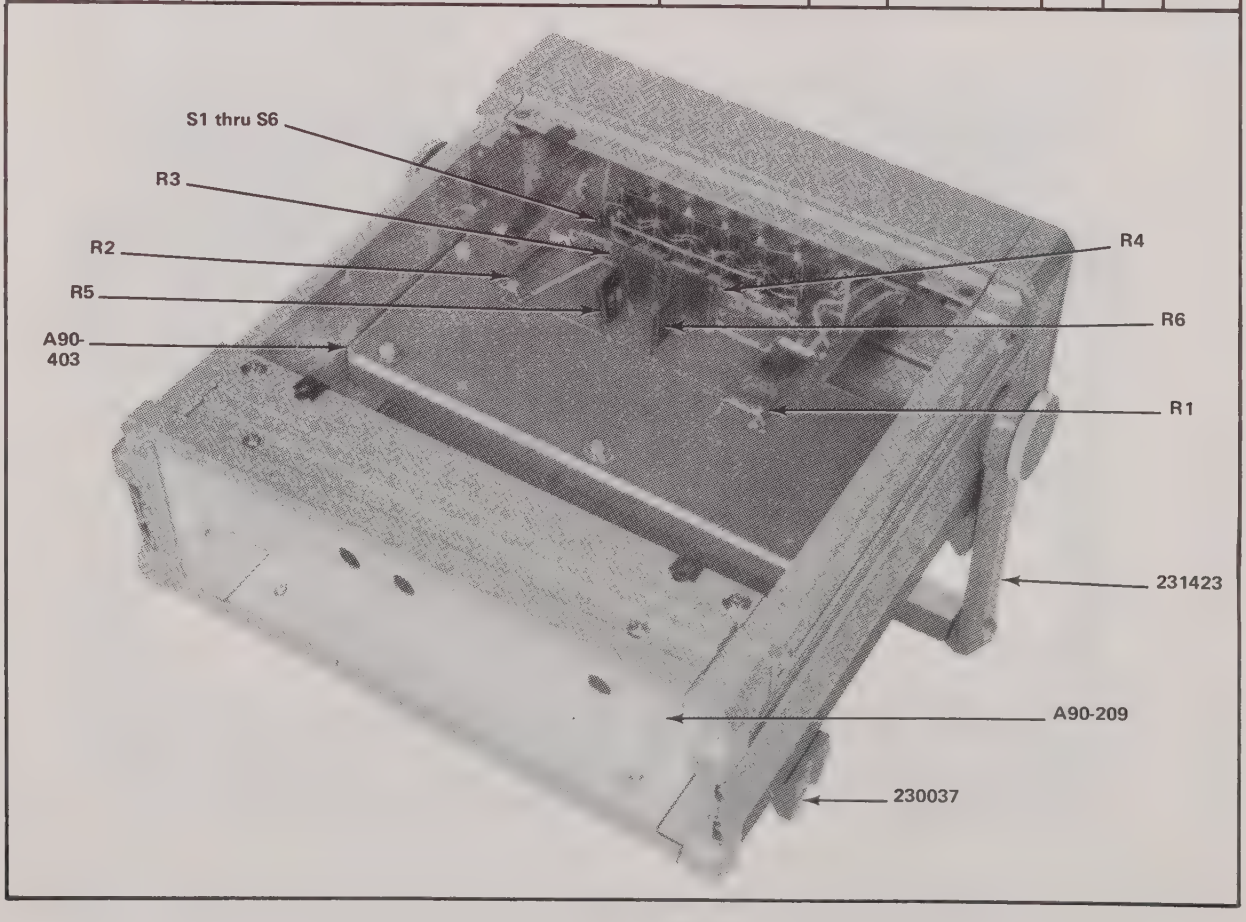
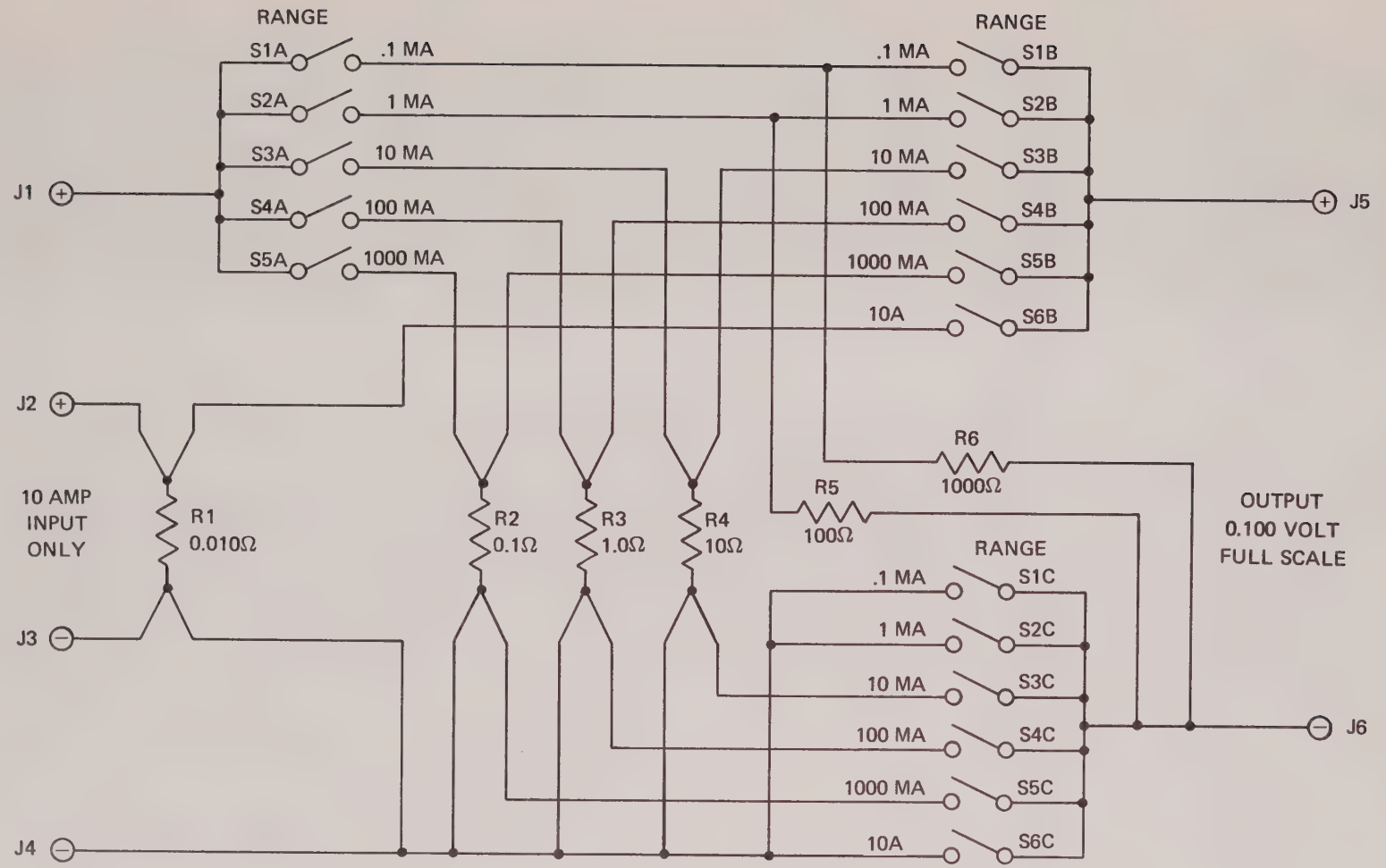


Figure 6-9. MODEL A90 CURRENT SHUNT (Sheet 2 of 2)



FUNCTIONAL SCHEMATIC DIAGRAM

MODEL A90

CURRENT SHUNT

SER. NO. 123 & ON

REV. a

FLUKE JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133

APPENDIX A

FEDERAL SUPPLY CODE FOR MANUFACTURERS

A-1. CODE TO NAME

A-2. The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Westlake, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
00779	AMP Inc. Harrisberg, Pennsylvania
01121	Allen-Bradley Co. Milwaukee, Wisconsin
01281	TRW Semiconductors Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Dallas, Texas
01686	RCL Electronics Inc. Manchester, New Hampshire
01730	Deleted
01884	Dearborn Electronics Inc. Orlando, Florida
02114	Ferroxcube Corp Saugerties, New York
02606	Replaced by 15801
02660	Amphenol-Borg Elect. Corp. Broadview, Illinois
02799	Arco Capacitors, Inc. Los Angeles, California
03614	Replaced by 71400
03651	Replaced by 44655
03797	Eldema Corp. Compton, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03888	Pyrofilm Resistor Co., Inc. Cedar Knolls, New Jersey
03911	Clairex Corp. New York, New York
03980	Muirhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegeman Electronic Company Hartford, Connecticut
04062	Replaced by 72136
04202	Replaced by 81312
04217	Essex Wire Corp Wire & Cable Div. Anaheim, California
04221	Aemco Div. of Midtex Inc. Mankato, Minnesota
04645	Replaced by 75376
04713	Motorola Semiconductor Products Inc. Phoenix, Arizona
05082	Replaced by 94154
05236	Jonathan Mfg. Co. Fullerton, California
05277	Westinghouse Electric Corp. Semiconductor Dept. Youngwood, Pennsylvania
05278	Replaced by 43543
05397	Union Carbide Corp. Electronics Div. Cleveland, Ohio
05571	Sprague Electric Co Pacific Div. Los Angeles, California
05704	Alac, Inc. Glendale, California
05820	Wakefield Engineering Ind. Wakefield, Massachusetts
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Replaced by 63743
06473	Amphenol Space & Missile Sys. Chatsworth, California
06555	Beede Electrical Instrument Co. Penacook, New Hampshire
06739	Electron Corp. Littletown, Colorado
06743	Clevite Corp. Cleveland, Ohio
06751	Semcor Div. Components Phoenix, Arizona
06860	Gould National Batteries Inc. City of Industry, California
06980	Eitel-McCullough, Inc. San Carlos, California
07115	Replaced by 14674
07138	Westinghouse Electric Corp Electronic Tube Div. Elmira, New York
07263	Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp Northampton, Massachusetts
07910	Continental Device Corp. Hawthorne, California
08530	Reliance Mica Corp. Brooklyn, New York
08792	CBS Electronics Semiconductor Operations-Div. of CBS Inc. Lowell, Massachusetts
08806	General Electric Co. Miniature Lamp Dept. Cleveland, Ohio
08863	Nylomatic Corp. Norrisville, Pennsylvania
08988	Skottie Electronics Inc. Archbald, Pennsylvania
09922	Burndy Corp. Norwalk, Connecticut
11237	Chicago Telephone of Calif. Inc. South Pasadena, California
11358	CBS Electronics Div. of CBS Inc. Newburyport, Massachusetts
11403	Best Products Co. Chicago, Illinois
11503	Keystone Mfg Div. of Avis Industrial Corp. Warren, Michigan
12014	Chicago Rivet & Machine Co. Bellwood, Illinois
12040	National Semiconductor Corp. Danburry, Connecticut
12060	Diodes, Inc. Chatsworth, California
12136	Philadelphia Handle Co. Camden, New Jersey
12323	Presin Co., Inc. Shelton, Connecticut
12327	Freeway Washer & Stamping Co. Cleveland, Ohio
12400	Replaced by 75042
12617	Hamlin Inc. Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Dover, New Hampshire
12749	James Electronics Chicago, Illinois

12856	Micrometals Sierra Madre, California
12954	Dickson Electronics Corp. Scottsdale, Arizona
13606	Sprague Electric Co. Transistor Div. Concord, New Hampshire
13839	Replaced by 23732
14099	Semtech Corp. Newbury Park, California
14193	California Resistor Corp. Santa Monica, California
14298	American Components, Inc. Conshohocken, Pennsylvania
14655	Cornell-Dubilier Electronics Newark, New Jersey
14674	Corning Glass Works Corning, New York
14752	Electro Cube Inc. San Gabriel, California
14869	Replaced by 96853
15636	Elec-Trol Inc. Northridge, California
15801	Fenwal Electronics Inc. Framingham, Massachusetts
15818	Amelco Semiconductor Div. of Teledyne Inc. Mountain View, California
15849	Useco, Inc. Mt. Vernon, New York
15909	Replaced by 17870
16332	Replaced by 28478
16473	Cambridge Scientific Ind. Inc. Cambridge, Maryland
16742	Paramount Plastics Downey, California
16758	Delco Radio Div. of General Motors Kokomo, Indiana
17069	Circuit Structures Lab. Upland, California
17856	Siliconix, Inc. Sunnyvale, California
17870	Daven-Div. of Thomas A. Edison Ind.--McGraw-Edison Co. Manchester, New Hampshire
18083	Deleted
18178	Vactec Inc. Maryland Heights, Missouri
18736	Voltronics Corp. Hanover, New Jersey
19429	Montronics, Inc. Seattle, Washington
19451	Perine Machinery & Supply Co. Seattle, Washington
19701	Electra Mfg. Co. Independence, Kansas
20584	Enochs Mfg. Co. Indianapolis, Indiana
22767	ITT Semiconductors Div. of ITT Palo Alto, California
23732	Tracor Rockville, Maryland
24248	Southco Div. of South Chester Corp. Lester, Pennsylvania
24655	General Radio Co. West Concord, Massachusetts
25403	Amperex Electronic Corp Semiconductor & Receiving Tube Division Slatersville, Rhode Island
28478	Deltrol Controls Corp. Milwaukee, Wisconsin
28520	Heyman Mfg. Co. Kenilworth, New Jersey
30323	Illinois Tool Works Inc. Chicago, Illinois
33173	General Electric Co. Tube Dept. Owensboro, Kentucky
37942	Mallory, P. R., & Co., Inc. Indianapolis, Indiana
38315	Honeywell Inc. Precision Meter Div. Manchester, New Hampshire
42498	National Company Melrose, Massachusetts
43543	Nytronics Inc. Transformer Co. Div. Alpha, New Jersey
44655	Ohmite Mfg. Co. Skokie, Illinois
49671	Radio Corp. of America New York, New York
49956	Raytheon Company Lexington, Maine
53021	Sangamo Electric Co. Springfield, Illinois
55026	Simpson Electric Company Chicago, Illinois
56289	Sprague Electric Co. North Adams, Massachusetts
58474	Superior Electric Co. Bristol, Connecticut
60399	Torrington Mfg. Co. Torrington, Connecticut
62460	Deleted
63743	Ward Leonard Electric Co. Mount Vernon, New York
64834	West Mfg. Co. San Francisco, California
65092	Weston Instruments Inc. Newark, New Jersey
66150	Winslow Tele-Tronics Inc. Asbury Park, New Jersey
70563	Amperite Company Union City, New Jersey
70903	Belden Mfg. Co. Chicago, Illinois
71002	Birnbach Radio Co., Inc. New York, New York
71400	Bussmann Mfg. Div. of McGraw-Edison Co. St. Louis, Missouri
71450	CTS Corp. Elkhart, Indiana
71468	ITT Cannon Electric Inc. Los Angeles, California
71482	Clare, C P. & Co. Chicago, Illinois
71590	Centralab Div. of Globe Union Inc. Milwaukee, Wisconsin
71707	Coto Coil Co., Inc. Providence, Rhode Island
71744	Chicago Miniature Lamp Works Chicago, Illinois
71785	Cinch Mfg. Co. & Howard B. Jones Div. Chicago, Illinois
72005	Driver, Wilbur B., Co. Newark, New Jersey
72092	Replaced by 06980
72136	Electro Motive Mfg. Co. Willimantic, Connecticut
72259	Nytronics Inc. Berkeley Heights, New Jersey
72354	Deleted
72619	Dialight Corp Brooklyn, New York
72653	G. C. Electronics Rockford, Illinois
72665	Replaced by 90303
72794	Dzus Fastener Co., Inc. West Islip, New York
72928	Gudeman Co. Chicago, Illinois
72982	Erie Tech. Products Inc. Erie, Pennsylvania
73138	Beckman Instruments Inc. Helipot Division Fullerton, California
73293	Hughes Aircraft Co. Electron Dynamics Div. Newport Beach, California
73445	Amperex Electronic Corp. Hicksville, New York
73559	Carling Electric Inc. Hartford, Connecticut
73586	Circle F Industries Trenton, New Jersey
73734	Federal Screw Products, Inc. Chicago, Illinois
73743	Fischer Special Mfg. Co. Cincinnati, Ohio
73899	JFD Electronics Co. Brooklyn, New York
73949	Guardian Electric Mfg. Co. Chicago, Illinois
74199	Quam Nichols Co. Chicago, Illinois
74217	Radio Switch Corp. Marlboro, New Jersey
74276	Signalite Inc. Neptune, New Jersey
74306	Piezo Crystal Co. Carlisle, Pennsylvania
74542	Hoyt Elect. Instr. Works Penacook, New Hampshire
74970	Johnson, E. F., Co. Waseca, Minnesota
75042	IRC Inc. Philadelphia, Pennsylvania
75376	Kurz-Kasch, Inc. Dayton, Ohio
75382	Kulka Electric Corp. Mt. Vernon, New York
75915	Littlefuse Inc. Des Plaines, Illinois
76854	Oak Mfg. Co. Crystal Lake, Illinois
77342	Potter & Brumfield Div. of Amer. Machine & Foundry Princeton, Indiana
77969	Rubbercraft Corp. of Calif. LTD. Torrance, California

78189 Shakeproof
Div. of Illinois Tool Works
Elgin, Illinois

78277 Sigma Instruments, Inc.
South Braintree, Massachusetts

78488 Stackpole Carbon Co.
St. Marys, Pennsylvania

78553 Tinnerman Products
Cleveland, Ohio

79136 Waldes Kohinoor Inc.
Long Island City, New York

79497 Western Rubber Company
Goshen, Indiana

79963 Zierick Mfg. Corp.
New Rochelle, New York

80031 Mepco
Div. of Sessions Clock Co.
Morristown, New Jersey

80145 API Instruments Co.
Chesterland, Ohio

80183 Sprague Products
North Adams, Massachusetts

80294 Bourns Inc.
Riverside, California

80583 Hammarlund Co., Inc.
Mars Hill, North Carolina

80640 Stevens, Arnold Inc.
Boston, Massachusetts

81073 Grayhill Inc.
La Grange, Illinois

81312 Winchester Electronics
Div. of Litton Industries
Oakville, Connecticut

81439 Therm-O-Disc Inc.
Mansfield, Ohio

81483 International Rectifier Corp.
El Segundo, California

81590 Korry Mfg. Co.
Seattle, Washington

82376 Deleted

82389 Switchcraft Inc.
Chicago, Illinois

82415 Price Electric Corp.
Frederick, Maryland

82872 Roanwell Corp.
New York, New York

82877 Rotron Mfg. Co., Inc.
Woodstock, New York

82879 ITT Wire & Cable Div.
Pawtucket, Rhode Island

83003 Varo Inc.
Garland, Texas

83298 Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330 Smith, Herman H., Inc.
Brooklyn, New York

83478 Rubbercraft Corp. of America
New Haven, Connecticut

83594 Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740 Union Carbide Corp.
Consumer Products Div.
New York, New York

84171 Arco Electronics, Inc.
Great Neck, New York

84411 TRW
Ogallala, Nebraska

86577 Precision Metal Products
Stoneham, Massachusetts

86684 Radio Corp. of America
Electronic Components & Devices
Harrison, New Jersey

86689 Deleted

87034 Marco-Oak Inc.
Anaheim, California

88419 Use 14655

88690 Replaced by 04217

89536 Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730 Replaced by 08806

90201 Mallory Capacitor Co.
Indianapolis, Indiana

90215 Best Stamp & Mfg. Co.
Kansas City, Missouri

90211 Square D Co.
Chicago, Illinois

90303 Mallory Battery Co.
Tarrytown, New York

91293 Johanson Mfg. Co.
Boonton, New Jersey

91407 Replaced by 58474

91637 Dale Electronics Inc.
Columbus, Nebraska

91662 Elco Corp.
Willow Grove, Pennsylvania

91737 Gremar Mfg. Co., Inc.
Wakefield, Massachusetts

91802 Industrial Devices, Inc.
Edgewater, New Jersey

91836 King's Electronics
Tuckahoe, New York

91929 Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934 Miller Electric Co., Inc.
Pawtucket, Rhode Island

93332 Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145 Replaced by 49956

94154 Tung-Sol
Div. of Wagner Electric Corp.
Newark, New Jersey

95146 Alco Electronics Products Inc.
Lawrence, Massachusetts

95263 Leecraft Mfg. Co.
Long Island City, New York

95264 Replaced by 98278

95275 Vitramon Inc.
Bridgeport, Connecticut

95303 Radio Corp. of America
Solid State & Receiving Tube Div.
Cincinnati, Ohio

95354 Methode Mfg. Corp.
Rolling Meadows, Illinois

95712 Dage Electric Co., Inc.
Franklin, Indiana

95987 Weckesser Co., Inc.
Chicago, Illinois

96733 San Fernando Electric Mfg. Co.
San Fernando, California

96853 Rustrak Instrument Co.
Manchester, New Hampshire

96881 Thomson Industries, Inc.
Manhasset, New York

97540 Master Mobile Mounts
Div. of Whitehall Electronics Corp.
Los Angeles, California

97913 Industrial Electronic Hdware Corp.
New York, New York

97945 White, S. S. Co.
Plastics Div.
New York, New York

97966 Replaced by 11358

98094 Replaced by 49956

98278 Microdot Inc.
Pasadena, California

98291 Sealectro Corp.
Conhex Div
Mamaroneck New York

98388 Accurate Rubber & Plastics
Culver City, California

98743 Replaced by 12749

98925 Deleted

99120 Plastic Capacitors, Inc.
Chicago, Illinois

99217 Southern Electronics Corp.
Burbank, California

99515 Marshall Industries
Capacitor Div.
Monrovia, California

Revised August 1, 1968
Using H4-1 and H4-2
Dated June , 1968

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON

SALES & SERVICE REPRESENTATIVES

ALABAMA
HUNTSVILLE
BCS Associates, Inc.
3322 South Memorial Parkway
Tel. (205) 881-6220
Zip 35801

ALASKA
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Instrument Specialists, Inc.
5950 Sixth Ave. South
Suite 106
Seattle, Washington 98108
Tel. (206) 767-4260

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PHOENIX
Barnhill Associates
4900 E. Indian School Road
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Zip 85251

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Instrument Specialists, Inc.
1109 S. Central Ave.
Glendale, California 91204
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2359 De La Cruz
Santa Clara, California 95050
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Rosemont, Illinois 60018
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INDIANAPOLIS
Cozzens & Cudahy, Inc.
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Zip 46234

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Electronic Marketing Assoc.
11501 Huff Court
Kensington, Maryland 20795
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Arlington, Massachusetts 02174
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13657 Grand River Ave.
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Zip 48227

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7710 Computer Ave.
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Lambert Field 63145
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SBM Associates, Inc.
1519 Stuyvesant Avenue
Union, New Jersey 07083
Tel. (201) 687-8737

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Barnhill Associates
827 Pennsylvania N.E.
Tel (505) 265-7766
Zip 87110

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Pleasantville, New York 10570
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528 Old Country Road
Plainview, Long Island 11803
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Zip 14625

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Zip 45409

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114 Spring Grove Road
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Ste. 220
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3810 Westheimer
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West Malaysia

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Durban, Natal, So. Africa

K. Baker (Pty.) Ltd.
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Swazilad, So. Africa

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West Germany

Rohde & Schwarz Handels - Gmbh
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Ernst - Reuter - Platz 10
West Germany

Rohde & Schwarz Vertriebs - Gmbh
2000 Hamburg 50
Grosse Bergstrasse 213-217
West Germany

Rohde & Schwarz Vertriebs - Gmbh
7500 Kalsruhe
Kriegsstrasse 39
West Germany

Rohde & Schwarz Vertriebs - Gmbh
8000 Muenchen
Dachauer Strasse 109
West Germany

In Europe contact FLUKE NEDERLAND, N. V., Post Office Box 5053, Tilburg, The Netherlands

List of Factory Authorized Service Centers

ARIZONA

PHOENIX

Arizona Standards Laboratory
4430 N. 19th Ave.
Tel. (602) 264-9351

CALIFORNIA

LOS ANGELES

Instrument Specialists, Inc.
P. O. Box 39908
2870 Los Feliz Place
Tel. (213) 665-5181
TWX: 910-321-3914

COLORADO

BOULDER

Ball Brothers Research Corp.
Standardization Laboratory
Tel. (303) 444-5300
TWX: 910-940-3241

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BCS Associates, Inc.
P. O. Box 6578
940 N. Fern Creek Ave.
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TWX. 810-850-0185

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EG & G Standards and Calibration Laboratory
P. O. Box 4339, Station A
933 Bradbury Drive S. E.
Tel. (505) 842-4084

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SBM Associates
28 Hobby Street
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TWX. 710-572-2193

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SBM Associates
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TWX. 510-253-6145

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Tel. (216) 881-0300

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Honeywell Metrology Service
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Tel. (513) 878-2551

TEXAS

GARLAND

Tucker Electronics Company
326 Kirby Street
Tel. (214) 272-3404

HOUSTON

Linear Standards Laboratory
8207 Millet
Tel. (713) 923-2796

UTAH

SALT LAKE CITY

Stabro Laboratory
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Tel. (801) 467-8011

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Fluke Netherland N. V.
P. O. Box 5053
Tilburg, The Netherlands

UNITED KINGDOM

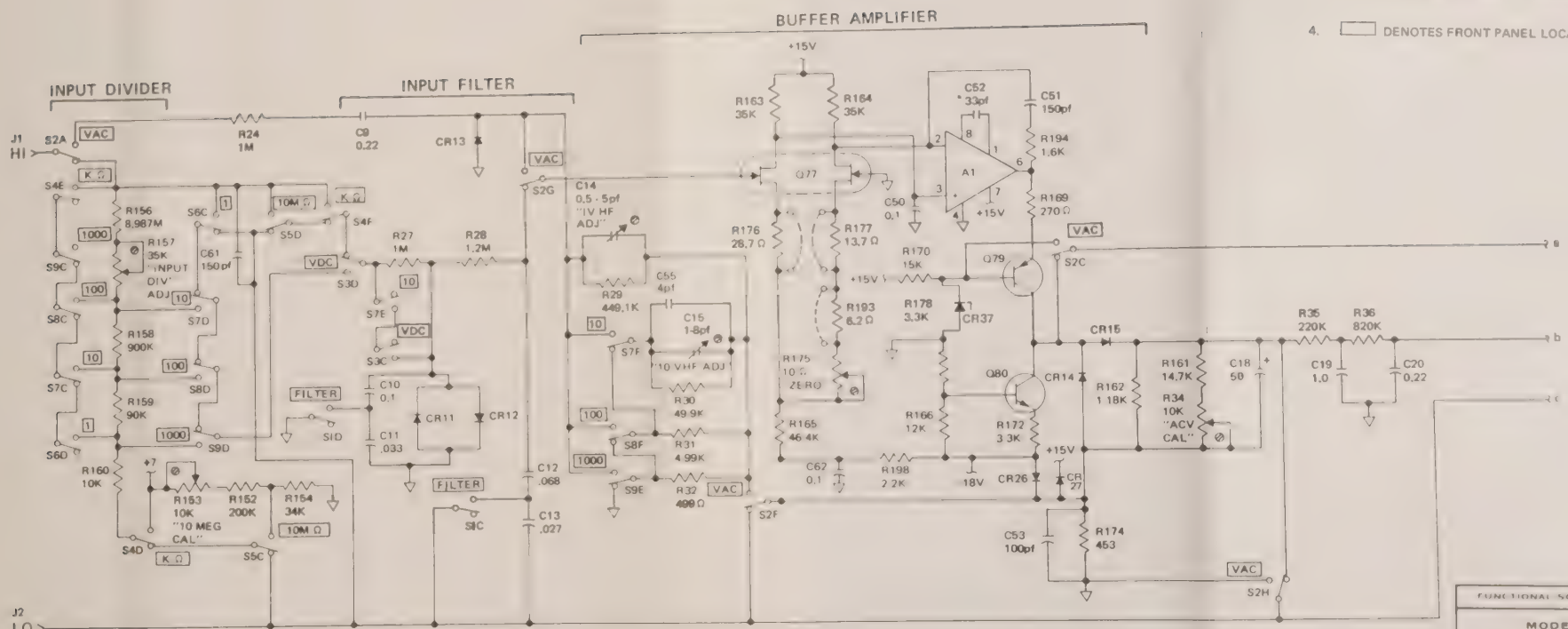
Fluke International Corp
P. O. Box 102
Watford-Herts, England

For information regarding service centers in other foreign locations, contact the nearest Sales and Service Representative in your area.

BUFFER

NOTES;

1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ALL SWITCHES SHOWN IN OFF POSITION.
3. ⊘ DENOTES INTERNAL SCREWDRIVER ADJUSTMENT.
4. ▭ DENOTES FRONT PANEL LOCATION.



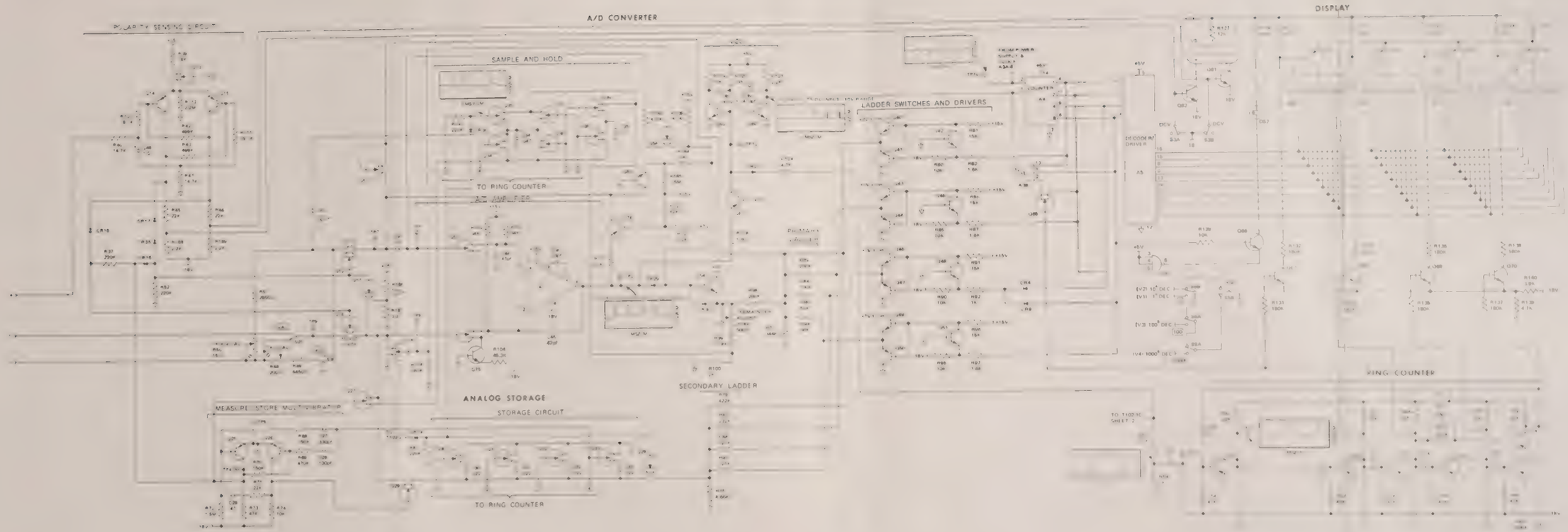
FUNCTIONAL SCHEMATIC DIAGRAM

MODEL 8100A
DIGITAL MULTIMETER

SCHEMATIC NO. 1

SER. NO. 201 & ON — REV. C

FLUKE — JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133



NOTES:

1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ALL SWITCHES SHOWN IN [illegible] POSITION.
3. ◇ DENOTES INTERNAL SCREWDRIVER ADJUSTMENT.
4. [illegible] DENOTES FRONT PANEL LOCATION.
5. R100 SELECTED IN FINAL CALIBRATION.
6. ⊘ DENOTES COMPONENT NOT PRESENT IN [illegible] UNIT.
7. MEASNUT TUBE PIN LAYOUT

	1 o	6 o	
	2 o	7 o	
	3 o	8 o	
RHOW	4 o	9 o	RLND
	5 o	10 o	

BOTTOM VIEW

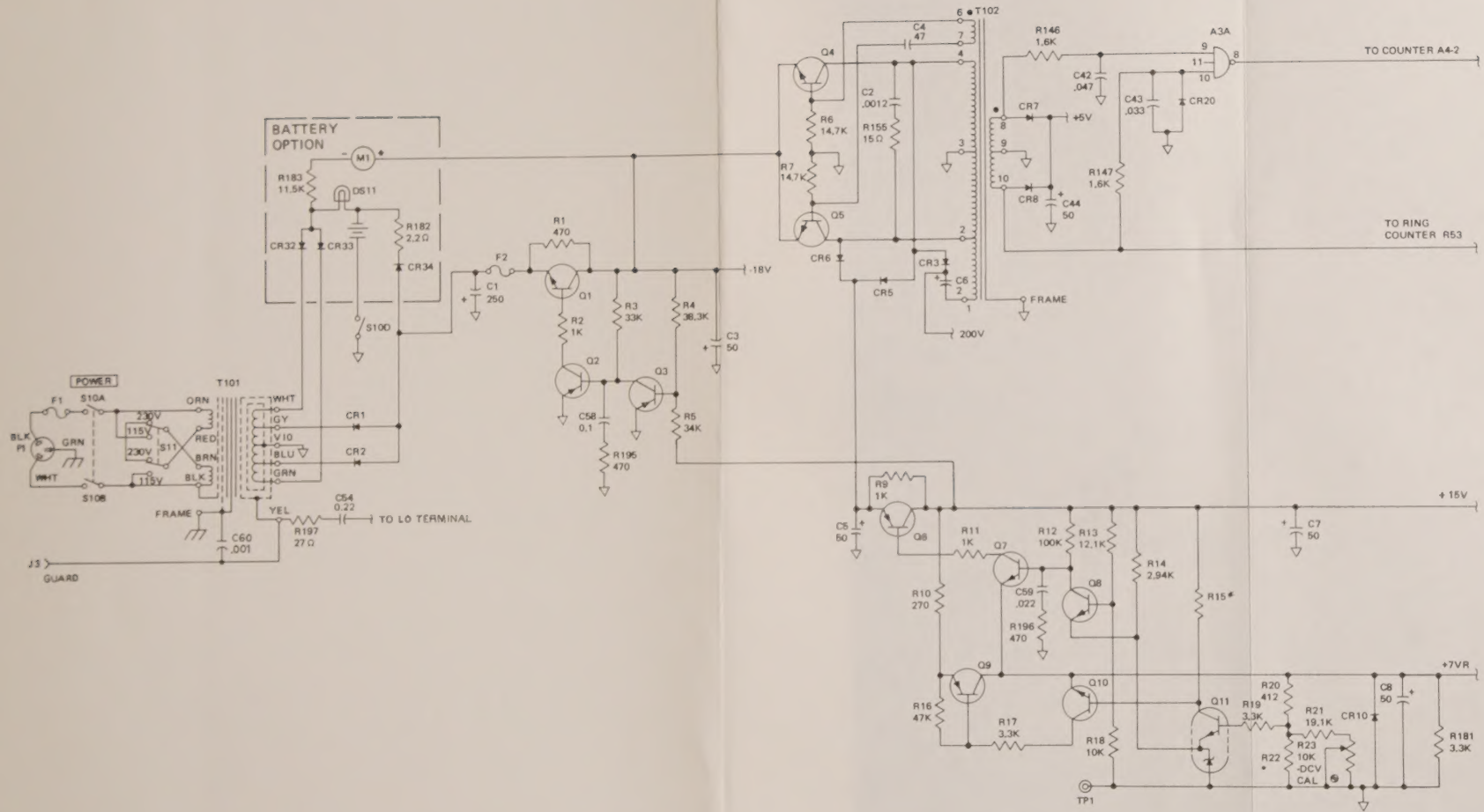
* PEAK GATE ON WITH POSITIVE INPUT MINOR GATE ON WITH NEGATIVE INPUT

FUNCTIONAL SCHEMATIC DIAGRAM

MODEL 8100A
DIGITAL MULTIMETER

SCHEMATIC NO. 2

FLUKE JOHN FLUKE MFG CO., IN
P.O. Box 7428 Seattle, Washington 9



1. *RESISTOR VALUE SELECTED AT TEST OF Q11.

FUNCTIONAL SCHEMATIC DIAGRAM

MODEL 8100A
DIGITAL MULTIMETER

SCHEMATIC NO. 8

SEE NO. 123 & ON

REV 6

FLUKE JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133